Vegetation Mapping of
Anza-Borrego Desert State Park and Environs

A Report to the California Department of Parks and Recreation

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Executive Summary

This document summarizes the methods and results of the vegetation mapping of Anza-Borrego Desert State Park conducted by the Natural Heritage Division of the California Department of Fish and Game. This effort involves new methodologies proposed to be used for many other significant natural areas in the United States. Therefore, it discusses them in some detail and includes recommendations based on the contractors experience with this project.

The mapping project blends ground-based classification, aerial photo interpretation, and GIS editing and processing. The method is based on the development of a quantitative vegetation classification which is used to describe the vegetation mapping units of the park. The classification is defined to meet the specifications of the new National and State standards for vegetation classification, but is related through a cross-walking table (Table 2) to other standard classifications in use locally or state-wide. The reporting of this information is broken into sections on field and lab- based methods, results and conclusions. In some cases it has been necessary to describe the processes involved from the standpoint of the vegetation classifier, delineator, and mapper. Thus, there is some inherent redundancy in the report, but this we trust

will be appreciated by the various specialists who may be interested in the product and the processes involved.

The mapping area as defined in the contract extends beyond the boundaries of the park to include much of the jointly managed public lands to the southwest of the park and portions of BLM land to the East of the Park. As a result of a lack of aerial photography, a small portion of the park (<1% of the mapped area) adjacent to Terwilliger Valley in Riverside County could not be included. The scope of the project does not cover the privately held area around Borrego Springs or the Ocotillo Wells State Vehicular Area. In collaboration with the San Diego Association of Governments (SANDAG), Natural Heritage Division agreed to map additional areas beyond the limits defined in the contract. These included most of the BLM's McCain Valley Resource Area, and BLM wilderness between Laguna Mountain and the western margin of the park, most of Los Coyotes Indian Reservation and additional smaller portions of land immediately west of the park boundary. In total a 928,090 acre area was mapped. Within this area 501 vegetation samples were taken and over 23,000 polygons were delineated and attributed. A total of 94 mapping units were used to depict the vegetation.

Introduction

Vegetation mapping has been an important step in the development of State Park general plans. A vegetation map has been shown to be valuable as a means of displaying the full array of biological diversity of any park planning unit, thus providing an efficient context in which to conduct natural resource planning. Although vegetation mapping has been standard practice for the planning process for many State Park units, for several reasons the philosophy and methodology of this mapping effort differs from any other vegetation map produced in California.

Concepts and standards for this map:

The methods and philosophy of this product reflects the protocol for "Field Methods for Vegetation Mapping" supported by the National Park Service and Biological Resources Division of the United States Geological Survey. This methodology (USGS 1997a) Is the standard for all new vegetation mapping efforts for U.S. National Parks. The rational for this protocol stresses the importance of a standardized vegetation classification for the United States - the National Vegetation Classification or "NVC" (USGS 1997b). All National Park mapping efforts will be tied to a single classification system. This evolving classification treats the vegetation of the country as a multi-resolution hierarchy, enabling description of vegetation from the local stand level all the way up to ecoregional-scale groupings. Thus, all parks mapped in this manner will include detailed data supporting not only the map but will simultaneously amass additional information for the growing NVC.

To accomplish this, that national classification relies on quantitative vegetation sampling data collected in the field. This data-driven principle is the same as in the recently produced classification of California vegetation described in Manual of California Vegetation ("MCV", Sawyer and Keeler-Wolf, 1995). The classification in the MCV was developed in conjunction with the standards for the National Vegetation Classification and the basic floristic elements of both classifications are equivalent in scale and meaning. The contract specifications for this project require that the classification of the map be based on the MCV. Thus, it was logical to also base the mapping methodology on the standards set by the National Park Service/Biological Resources Division.

Basing the mapping units on locally derived sample analysis and classification:

A typical vegetation map uses a predetermined classification. The vegetation polygons are labeled with these classification units prior to any extensive field time (for example see San Diego County vegetation map, SANDAG 1996 based on the Holland 1986 classification). The methodology used in this mapping effort requires a quantitative sample based classification. Because the quantitative vegetation classification efforts have been non systematic in California, huge areas of the State lack data-driven descriptions of vegetation units. The Anza-Borrego Desert State Park was one of those regions. Thus, a vegetation classification had to be defined before the map could be labeled.

In comparison with existing classifications for the State, the MCV is complex. The number of vegetation series and associations (see definition of words in classification section) already described outnumber the other existing detailed classifications such as Holland (1986) or CALVEG (Parker and Matayas 1979). The basic vegetation units of MCV are based on dominant and characteristic species, not on general habitat considerations, for example, the Holland (1986) category “Sonoran desert woody and succulent scrub” contains several MCV series such as Desert agave, Teddy-bear cholla, Brittlebush, Ocotillo, and Creosote bush-burrobush. Therefore, the level of investigation to define floristic classification vegetation units in this map was substantial. An intensive data collection and development phase preceded the labeling phase.

Delineating vegetation in the desert:

Although it was impossible to pre-label the vegetation polygons for this map, it was necessary to define polygons-or “delineate” to move on with sample allocation and to complete the map in a timely fashion. Delineation of sparse desert vegetation requires an ability to use surrogates for transitions from one vegetation type to the next, because many of these transitions are invisible even from relatively large scale aerial photographs. Our delineation team spent a large amount of the time in the park visiting numerous localities and noting the correlation between various environmental effects such as landform, aspect, geology, elevation, and moisture upon the patterns of vegetation. This information was used to extrapolate vegetation patterns. Thus, despite the lack of any distinctive change in vegetation signature from remote sensing, polygon delineation based on a distinct aspect or landform change could be warranted if supported by field evidence. A large portion of the sparsely vegetated lower elevations of the park was delineated in such a fashion.

Value of the approach:

Both precise vegetation maps and detailed classifications of vegetation are needed for ecosystem-level resource assessment. A quantitative hierarchical vegetation classification is useful to describe the full range of variation for ecological management from the species population level to the bioregional level. A map that is capable of matching this classification has the advantage of displaying the spatial distribution of these vegetation types so systematic planning can occur across the entire mapping area. By basing the map classification on extensive field data it is also possible to support a value-added approach, delivering more than just a distribution of vegetation types. For example, in this product we provide information relating to on-the-ground impacts. We did this by categorically noting threat (as defined as any non-natural effect on stands of native vegetation) and threat intensity for each of the 500 samples taken in the park. These data are provided with the map coverage and can give a picture of which types of vegetation have which types of threats associated with them.

Setting a precedent:

This project provided the Department of Fish and Game's Natural Heritage Division (DFG-NHD) the first opportunity to undertake a vegetation mapping project using the NPS-NBS methodology. It is also the first large (>100,000 acre) area in the United States to be mapped in this way. Since the beginning of this effort DFG-NHD has become involved in vegetation mapping efforts of several other nationally significant areas using similar methods, including Yosemite and Joshua Tree National Parks, Pt. Reyes National Seashore, Golden Gate National Recreation Area, the Suisun Marsh, and the majority of the California Mojave Desert. Thus, this mapping effort at Anza-Borrego has been a proving ground and has provided training for what is rapidly becoming a standard approach for many natural areas.

Methods for Vegetation Sampling and Classification

For this project, the primary basis for attributing the vegetation map stems from the collection and analysis of vegetation samples. Therefore, substantial thought and effort was put into the development of a field sampling protocol and allocation of samples throughout the park and environs.

Sampling Protocol:

The foundation for the vegetation sampling field form used in this project was the California Native Plant Society (CNPS) Vegetation Sampling Protocol (see Sawyer and Keeler-Wolf 1995). This methodology was developed for simple quantitative vegetation sampling repeatable in many vegetation types throughout California. However, several modifications were made to the CNPS protocol based on the specific needs from this project. These are described below:

1. Because the area to be mapped was extensive and time for repeated sampling was limited, the

50 m line intercept described in the CNPS protocol was replaced with an ocular estimating procedure. This took less time on average than the transect and allowed an estimate of cover for all species enumerated over a larger area.

2. The vagaries of desert climate and the need to collect data in all times of the year due to the short duration of this project reduced our ability to detect annual species. Thus, unlike the CNPS protocol, only biennial and perennial herbs, shrubs and trees were assessed in the samples.

3. The samples taken had to be representative of the entire delineated map polygon with as few replications as possible. Thus, the size and shape of the sample was increased from the standard CNPS 5 x 50 m (250 m sq.) rectangle to a much larger, but variable-size plot based on the physiognomy of the vegetation. Open desert vegetation was typically sampled in a triangular plot that was about 2100 m sq (legs of triangle were 70 m long). Dense chaparral and other montane vegetation were typically sampled in a triangular plot about 1250 m sq (50 m legs). Other plot shapes were used depending on the general dimensions of the vegetation polygons to be sampled (e.g., long riparian corridors were typically sampled as long strips that totaled the same area as the other dense vegetation samples, 1250 m sq). Plot size and shape were recorded on each field form. The variable size and shape of the plot based on the physiognomy of the vegetation and the fact that we collected estimates of cover for species rather than exact measurements exemplify characteristics of a phytosociological relevé (see Barbour et al 1992) rather than a fixed plot or point-intercept sample.

4. Some additional environmental variables were added to the sampling sheet based on specific desert topography and landforms (see example data sheet and field form, Appendix 1)

5. Global positioning systems were used to locate the centers of the samples and additional information regarding GPS file name and duration of data collection were added to the field form.

6. Record keeping was based on the assignment of plots to a particular vegetation polygon number. First, a preliminary number was given to the sample based on the aerial photo covering the area of the sample and individual numbers of polygons within that photo. The polygon numbers were re-assigned following entry of all polygons into the GIS system.

7. Cover values for the perennial species were assigned based on a six point scale (see example data sheet). In addition, estimates of percent cover were required for all species greater than or equal to 1% cover. Additional fields for total vegetation cover, and total tree, shrub and ground cover were added. These were thought to be important for such polygons attributes as total cover estimates.

8. A separate entry for non-natives was added to help with assessing impacts of invasive species. The cover of non-natives was assessed whether annual or perennial, but totaled as a separate entry in the field form. This information was used to rank threats based on invasive exotics to each vegetation polygon sampled (presented in the digital GPS database)
9. As with plant species, the cover values for coarse fragments (bedrock, gravel, cobble, stone,

litter) were estimated in cover classes and percent throughout the plot.

Sample Allocation:

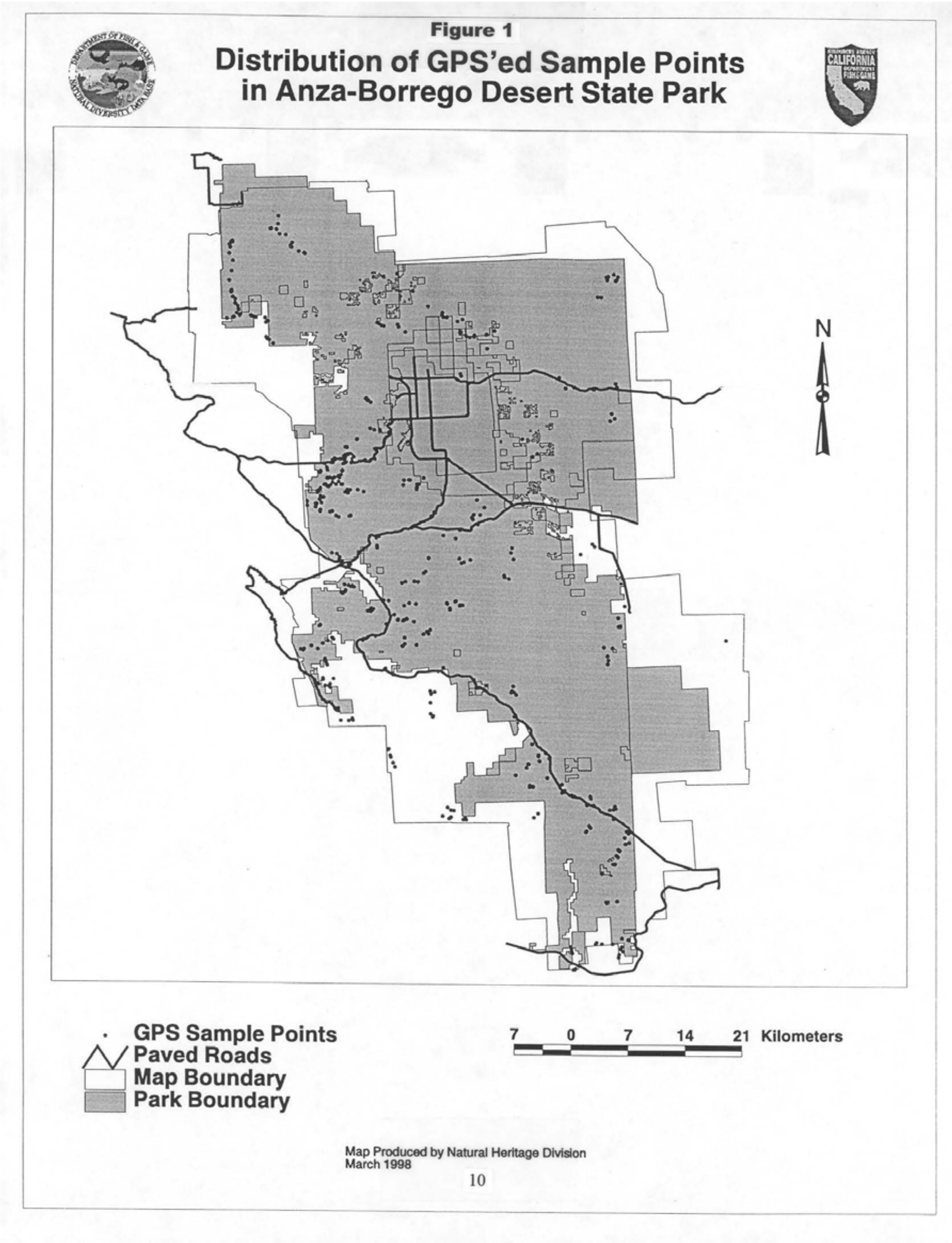
The general notion of the selection of samples followed the philosophy of the National Park Service/Biological Resources Division of USGS document "Field Methods for Vegetation Mapping" (full document available at http://biology.usgs.gov/veg.html). Because no complete quantitative vegetation classification existed for the park, we had to create one by sampling as broadly as possible throughout out the mapping area. Without a prior knowledge of all mappable types of vegetation in the park, our concept was to sample the full range of variability of environments likely to influence the vegetation at the scale at which we were mapping. This meant we were looking for variation in elevation, slope exposure and steepness, as well as variation in latitude, geologic substrate, and landform.

Initially we had hoped we could make use of existing GIS layers to stratify our samples using a "gradsect" methodology (Gillison and Brewer 1985). The concept of gradsect as adapted for use with a GIS system is to select GIS layers that mirror the basic environmental variables driving the variation and distribution of vegetation. Then, subdividing these layers into classes all unique combinations of these overlapping variables are identified. For example, topography could be divided by 1000 ft. contour intervals and aspect could be divided into the four cardinal directions, while landforms could be grouped into categories based on depositional environment - alluvial fans, mountains, sand dunes, playas, and geology could be subdivided into igneous, metamorphic or sedimentary types, etc. Based on their extent and likely influence on vegetation, a proportional number of randomly chosen environments located in the park are selected for sampling.

Unfortunately, it soon became clear that the GIS coverages for the park and environs were inadequate for this type of analysis and sample allocation. For example, no digital geology layer existed, and initially there were technical problems with the digital topography layer. We had no time and no budget to create or modify these and other layers. As a result, we prepared a manual gradsect sample strategy of the park.

We expected that the extreme topographic gradient from east to west across the park was likely to be the strongest influence on the vegetation patterns (mirroring the ultimate driving variables of moisture availability and temperature), followed by lesser influence of landform, substrate (geology), latitude and aspect differences. Thus, we developed a strategy that focused on the selection of samples in accessible portions of the park that met these requirements. In order to be most effective, we choose to start with the spring sampling of both 1996 and 1997 at the lower elevations and worked higher as the season warmed and progressed.

Distribution of GPS'ed Sample Points in Anza-Borrego Desert State Park



Sketch of a Sampling Mission:

Our sampling forays were broken into individual missions in which from one to several days were focused on a set of aerial photos that represented a certain set of environments in the park. Within these delineated photos, polygons were selected for sampling based on accessibility, visual distinctiveness, and elevational, aspect, and substrate variability. Polygons for sampling were subjectively located prior to entering the field from the aerial photos. The selection was based on a combination of the above desired features. Once within the polygon, two-person field crews would locate the center of the sampling plot based on a reconnaissance of the entire vegetation polygon, the plot being positioned in a representative area. Plot boundaries were typically laid out by compass and pacing the appropriate length for boundaries, corners were marked with flagging or other visible markers.

The First Sampling Season:

Sampling began in March 1996 at the lowest elevations of the park. All passible roads were noted, and general environmental settings were identified along the roads. With the concomitant delineation of the low elevation photographs, we were able to keep allocating samples across an array of low elevation environments. Following the passing of the spring and with the expansion of photo delineation into selected upper elevations, we gradually moved sampling into the mid- and upper elevations. By the end of the first field season (mid- June 1996) we had sampled an array of environments from the lowest to the highest elevations and from the northern to the southern portion of the park. The strategy was to collect a broad array of samples which would give us a generalized view of the vegetation when classified using TWINSPAN (see classification section). At the end of the 1996 field season we had collected 228 vegetation samples.

Interim Analysis:

In the summer of 1996 the first set of samples were analyzed and the results of the interim classification were used to further develop the sampling scheme for the next sampling season. Following the TWINSPAN analysis of the first season's data we identified gaps in the classification. These were based on known types of environments or vegetation we had not been able to sample as well as "hints" in the initial classification of the 228 plots that a vegetation type occurred, but insufficient data existed to substantiate it. For example, if a single sample seemed to represent a very distinct vegetation type and we knew that type existed elsewhere in the park, we would select additional samples of it in the second field season.

Analysis of representation of topographic classes was also undertaken. After some correction by Mike Tuffly of our GIS staff, the existing digital topographic layer was used to partition the park into five 1000 ft. topographic classes (<1000 ft., 1000-2000, 2000-3000, 4000-5000, and >5000 ft.). Slope and aspect calculations were also made based on this GIS layer. Four aspect classes encompassing 90° quadrants (centered on the following directions: NE, SE, SW, and NW) were identified for the 228 georeferenced sample points. These were also coded based on their slope steepness (<1°, 1-10°, 11-25°, and >25°), derived from GIS analysis. Histograms of the distribution of the plots were produced that displayed the relative proportion of plots allocated to these different topographic classes. Based on these data we adjusted representation of samples for the next field season to allocate more plots to under-sampled classes.

A plot map was produced showing the distribution of the existing GPS sample points and was overlain over the park boundary. This provided us with a graphic representation of the spatial distribution of plots and quickly pointed out areas where samples were still required.

The Second Sampling Season:

The second season began in October 1996. We continued to sample the gaps in the mid- and lower elevations, based on the above criteria, through mid-April and again visited the higher elevations in late April and May. A total of 272 samples were collected in the second season.

Review of the Sample Allocation:

At the end of this project we can see the distribution of all samples with GPS points taken (see Figure 1). Approximately 30 of the 500 plots are not represented on this figure due to lack of, or insufficiently accurate GPS readings. Figure 1 depicts the widespread distribution of the samples. These samples when overlain with topographic, geologic, and landform maps can be seen to cover all major environments in the mapping area.

The lack of roads and trails in some parts of the park and our reliance upon roads and major trails to access sample points suggests that certain parts of the park may be under-represented. However, most variation in topography, landforms, and geologic substrate has been addressed. The only area which appears sufficiently unique from which we have no samples is the mid- and upper slopes of the Santa Rosa Mountains (Villager Pk. and adjacent areas in the NE part of the park). We have relied heavily on the field experience of other park employees (M. Jorgensen) for vegetation information from this area.

Photographic and Field Data Archives:

When collecting field data, photographs of the relevés were taken for documentary reference. The direction in which the photo/slide was taken was recorded on the field forms; this information was transferred to a log. The log was created in table format with the identity of the photographer on the left column, followed by date taken, frame number, field crew members, location in the park, and polygon number continuing to the right. All of these elements help the photographer determine where each print/slide belongs in the archives. The print or slides are marked with date, polygon number and direction the photo was taken and placed in print/slide archival pages. These archives are stored with the field data forms. Prints and slides proved to be useful in making decisions about polygon labeling and assigning certain transitional vegetation samples to a vegetation series or association. Data forms used to collect information in the field were stored in alphanumerical order by aerial photo. Prints and slides of the field plots were stored with the data forms.

Data Entry:

Vegetation data from the field forms was entered into a microcomputer using an ASCII text editor in the standard 80 place columnar matrix structure known as Cornell Condensed Format ("ccf" Mohler 1987a). In order to develop this matrix we first listed all species encountered in the samples, noting in which vegetation layer they were found – ground (<1meter), shrub (1-3m), or tree (>3m) layer. This list was converted from entire names to four letter codes with layer indication. For example, *Acacia greggii* in the ground layer is coded ACGR-G. In most cases the first two letters of the genus and species names are used. When duplications appeared the codes were adjusted to reflect the individuality of the species. For example *Arabis pulchra*, *Arctostaphylos pungens*, and *Aristida purpurea* are differentiated as ARPU – 1S, ARPU – 2S, and ARPU – 3S. Each code was given a number. For a complete list of all species and codes encountered in the field work for this report please see Appendix 3. Field data forms, previously numbered by polygon were given sample code numbers.

On the field data forms, cover of species is recorded by cover class and or percentage. We chose to enter data by selecting the mid-point of the cover class listed for each species on the field forms. Cover class 1 (<1%) was entered as 0.5%, cover class 2 (1-5%) was entered as 3%, cover class 3 (>5-25%) was entered as 15%, cover class 4 (>25-50% was entered as 37.5%), cover class 5 (>50-75%) was entered as 62.5%, and cover class 6 (>75%) was entered as 87.5%. In this case, vegetation sample numbers are listed in ascending order in the left-hand columns, while all species code numbers and cover values associated with each sample are listed in a series of columns to the right of the sample code number. The number of columns and other formatting rules are governed by a Fortran statement preceding the listing of the data. An alphabetical list of 6 character species codes associated with their unique numerical codes is entered at the end of the data matrix. The various analytical programs associate the character codes with the numerical codes to produce a print-out of species associated with each sample or cluster of samples for each run of the analytical programs.

Data Analysis:

Following the archiving of vegetation data and coding into Cornell Condensed Format the data was run through three programs from the Cornell Ecology Package (Mohler 1987a). These programs included:

1) "COMPOSE" (Mohler 1987b), a error checking and data structuring program, which allowed all entered data to be quality controlled for coding and afforded the ability to change certain settings in species values and perform global data transformations.

2) "COMPCLUS" (Gauch 1979), a rapid clustering program for large data sets. This program shows relationships in terms of similarity between all samples taken and demonstrates the degree of individuality of the field samples.

3) "TWINSPAN" (Hill 1979), a polythetic divisive technique which produces an ordered, two-

way classification of species and samples.

Because TWINSPAN was the most heavily relied upon of the three programs some further explanation of its logic and use is necessary. To arrive at an ordered species-sample matrix TWINSPAN first orders the matrix of species and samples using Reciprocal Average Ordination (abbreviated RA, Hill 1979). Ordination is the representation of species and sample relationships in a conceptually simplified arrangement. The end product is often a graph with similar samples or species near each other and dissimilar ones far apart. RA is an ordination technique related conceptually to weighted averages where the species ordination scores are averages of the sample ordination scores, and reciprocally, the sample ordination scores are averages of the species ordination scores (Gauch 1982). TWINSPAN then divides the RA ordination axis into two equal parts for both the species and the vegetation samples. It then re-orders each half using RA ordination, divides each half, re-orders, and so on until a specific number of divisions is reached. The resultant community classification is hierarchical, with the first several division levels corresponding to major vegetation units (see key and summary Table 1 in next section).

TWINSPAN and COMPOSE can interact to produce a large number of settings that may vary the output of the classification. These variations afford manipulations of the weightings given by the program to species cover, the number of divisions specified in the classification, and the ability to eliminate certain species or samples which may be anomalous and skew the results.

Our analysis of the data relied on multiple separate runs of TWINSPAN where these parameters were altered. This method was used to demonstrate robustness of the final classification described in the following pages. Interim classifications and other analyses were run following the end of the first field season. These allowed us to see the developing relationships between samples and help select additional samples and likely sample locations for next year's efforts.

The use of COMPCLUS also allowed us to see the relative similarity of plots and gave us a sense of where we needed more samples and where we had sufficient samples. COMPCLUS was also useful in demonstrating general ecological relationships between samples. COMPCLUS functions by seeding a predetermined number of randomly chosen sample codes and then clustering an array of related samples around these seed samples. The settings for the degree of similarity selected as the sphere around each random sample chosen can be varied. The varying number of samples attached to each randomly chosen seed sample quickly demonstrates the number of samples collected that are either very similar to each other or very different. COMPCLUS analysis of the complete data set for the park suggests that the low elevation upland desert samples are all quite similar. Thus, burrobush, creosote bush, creosote bush - burrobush, brittlebush, teddybear cholla, *Fagonia*, and other low elevation upland types show a strong similarity between each other and are much less individuated than various types of chaparral, woodland, or wetland types. This makes sense ecologically when we think about the rarified number of perennial species in the hottest driest part of the park and the degree to which species are shared between these different low elevation upland series.

The final analysis for the definition of classification units proceeded by first running several separate TWINSPAN settings on the entire data set. These included settings where the species values were relativized (all species cover transformed to total to 100), set to presence and absence only, reduced to just a few coverclass intervals (e.g., all species less than 5% and all species > 5%), and inclusion and elimination of rare species (e.g., those only found in a few samples) in the analysis. This was done to establish the consistency of the basic split between the first divisions (e.g, what turned out to be division A and B in the key). Following this assessment, each division was subjected to more intensive analysis where parameter settings were further manipulated. The final classification was based on the following settings: 12 divisions specified, pseudo-species cut values set to match the cover class intervals in the field form, and no weighting of any coverclass.

In some cases further refinement was obtained by reviewing the actual percent cover values of certain species in certain samples and thus refining the distinguishing characteristics of the series and associations beyond what was apparent in the data matrix. In general, associations were conservatively defined by their uniqueness and the presence of 3 or more redundant samples. The lack of many defined associations within most series (see summary of classification Table 1) points to the general philosophy of this mapping effort. The requirement as specified in the contract was to map at the series level. Thus, we needed to define series quantitatively and focused our field efforts in collecting enough samples to defined series. Associations were only defined for relatively distinct types that became distinguishable with just a few samples. It is likely that for a full association-level classification to be developed for the park at least twice the number of samples would need to be collected.

The classification although based on the MCV (Sawyer and Keeler-Wolf 1995) has gone beyond that document by quantifying the existence of several new types. These new series will be added to the next version of the state vegetation classification:

Ironwood (*Olnea tesota*)
Blue palo verde (*Cercidium floridum*)
Smoketree (*Psorothamnus spinosus*)
Desert willow (*Chilopsis linearis*)
Desert lavender (*Hyptis emoryi*)
Cheesebush (*Hymenoclea salsola*)
Baccharis emoryi
Desert agave (*Agave deserti*)
Schismus barbatus
Fagonia laevis
Broom baccharis (*Baccharis sergiloides*)
Pink-bracted manzanita (*Arctostaphylos pringlei* ssp. *drupacea*)
Mixed point-leaf -pink bracted manzanita (*A. pungens-A. pringlei drupacea*.)
Muller oak (*Quercus cornelius-mulleri*)
Deerweed (*Lotus scoparius*)
Desert apricot (*Prunus fremontii*)
Sugarbush (*Rhus ovata*)
Wright's buckwheat (*Eriogonum wrightii membranaceum*)

Creosote bush-Mojave yucca series (*Larrea tridentata-Yucca schidigera*)
Desert sunflower (*Viguiera parishii*)
Red brome (*Bromus madritensis rubens*)

Impacts:

To assist the park staff in understanding more of the non-natural impacts in the park we are providing a GIS link with on the ground sampling information. For every vegetation sample taken, field crews also collected information on non-natural impacts to the vegetation. We hope that these data can be used by the park to develop management decisions based on threats to certain vegetation types.

The data collected reflected an actual visible impact within the sampling area. Threats were not inferred (e.g., if the sample was adjacent to a road, mine, or trail but did not have any visible effects from that human disturbance it was not noted as an impact). We were conservative in the treatment of the impacts and did not make any assumptions beyond actual field sampling sites, as to where these impacts may occur. Thus, for the sampled portion of approximately 500 polygons (ca. 2.5% of all polygons in the mapping area) we have positive sighting information on impacts. These impacts are contained in the lookup table associated with the GPS sample sites (see metadata in Appendix 5).

The impacts data has not been summarized or analyzed yet. Based on this work and possibly additional sampling by park staff, a number of interesting analyses could be undertaken. Potentially this could be the start of a field-based GIS database that would track the occurrence of various impacts throughout the park. For example, the understanding of invasions of various non-native plants could be tracked, predicted based on their affinities for certain vegetation types, and subsequent management planning for their removal could thus be aided. With recurrent sampling and GPS relocation and GIS sampling in some problem areas effectiveness of monitoring and management practices for these impacts could be increased. The intersection of rare communities with particular real or potential impacts could also be analyzed and avoidance, minimization or other mitigation of these impacts could take place.

The following list of impacts with their accompanying codes is those used by the California Natural Diversity Data Base. Not all codes are appropriate for non-natural impacts on vegetation, but the entire list was included with the sampling field form for completeness. For the purposes of this project if one or more impacts were noticed on a field sample, they were noted on the field form and coded by their intensity. Intensity was ranked on a nominal scale of 1 (light), 2 (moderate), or 3 (heavy). Field crews were calibrated on the most common impacts such as code 05 (competition from exotics), 15 (road/trail/ construction maintenance), 19 (Vandalism/dumping/litter), and 20 (Foot traffic/trampling).

List of Impacts Used in Field Sampling for Vegetation Map:

01 Development

02 ORV activity
03 Agriculture
04 Grazing
05 Competition from exotics
06 Logging
07 Insufficient population/stand size
08 Altered flood/tidal regime
09 Mining
10 Hybridization
11 Groundwater pumping
12 Dam/inundation
13 Other
14 Surface water diversion
15 Road/trail construction/maintenance.
16 Biocides
17 Pollution
18 Unknown
19 Vandalism/dumping/litter
20 Foot traffic/trampling
21 Improper burning regime
22 over collecting/poaching
23 Erosion/runoff
24 altered thermal regime
25 Landfill
26 Degrading water quality
27 Wood cutting
28 Military operations
29 Recreational use (non ORV)
30 Nest parasitism
31 Non-native predators
32 Rip-rap, bank protection
33 Channelization (human caused)
34 Feral pigs
35 Burros

Delineation and Labeling Methods

Delineation:

The map produced by this project is based on interpretation of aerial photographs combined with field investigation. The Department of Fish and Game borrowed aerial photographs from three flights from the Department of Parks and Recreation to cover the entire park. The majority of the park was covered by 67 photos taken at a scale of 1:24,000 in October and November of 1992 by Aerial Fotobank, Inc. of San Diego. These true color photographs were provided as laminated 18 x 18 inch prints. Three (3) additional large format photographs flown at a scale of 1:48,000 and then enlarged to 18 X 18 inches were dated June 30, 1993. The final set of 25 photographs was 9 X 9, 1:48,000 prints from the northern and eastern edges of the unit flown in June and July, 1996. See Figure 2 for details of the photo coverage.

The term “delineation” as used in this project refers to the process of drawing the outlines of the vegetation as interpreted from the aerial photographs. Based on many years of experience interpreting aerial photographs, project staff delineated the irregular shapes of differing photographic signatures (polygons) which appeared to represent vegetative units directly on the laminated photographs with a .2 mm water-soluble pen (Uniball Microroller). The 9" x 9" photographs were delineated on transparent inking film overlays. Kari Lewis, Todd Keeler-Wolf, and Cynthia Roye were responsible for the majority or the delineations. Ryelle Leverett and Scott Collier also delineated portions of the park.

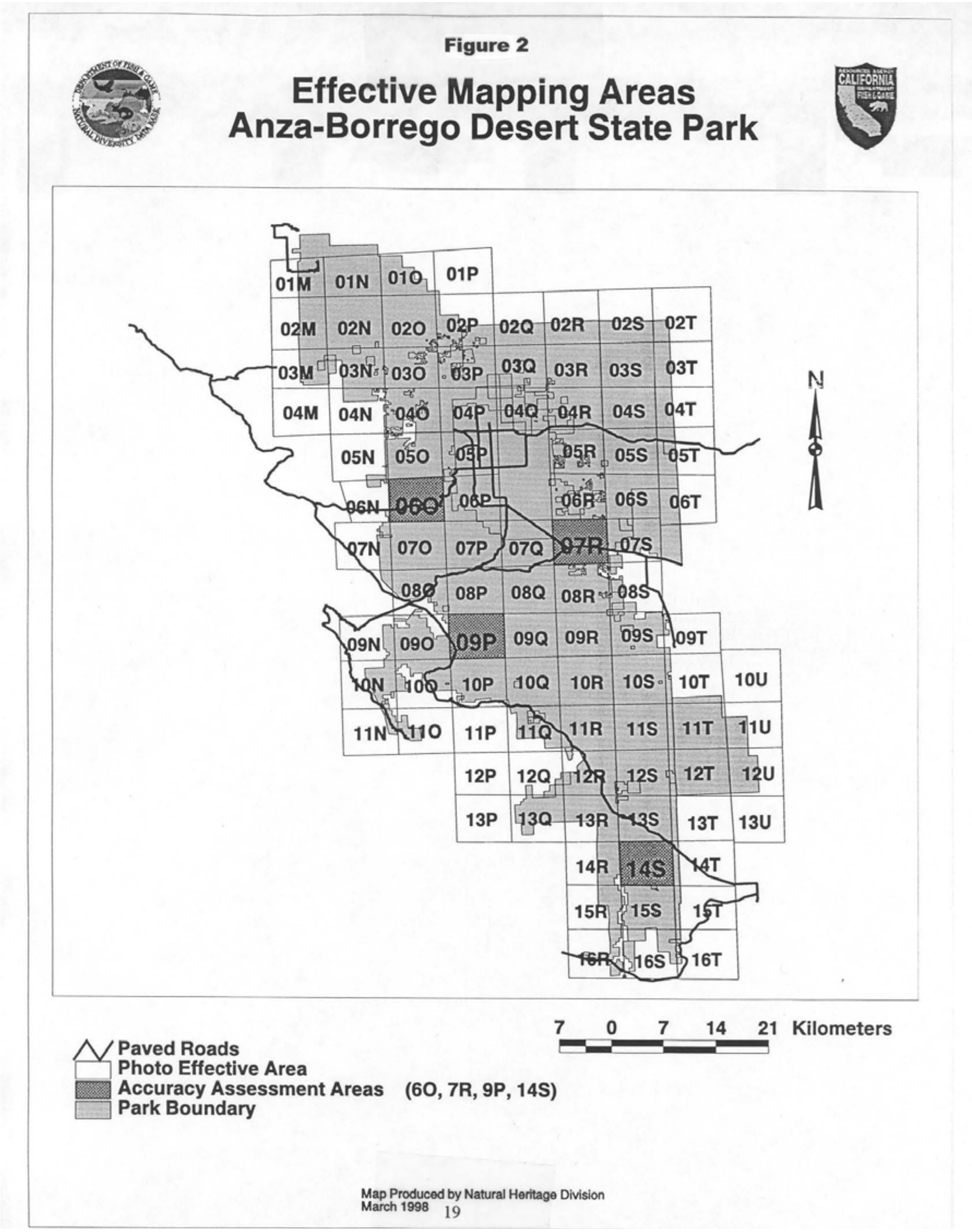
The minimum mapping unit for this project for most types of vegetation was 5 acres: a minimum of 1 acre was specified in the contract for several wetland and riparian types and certain upland woodland types. Delineation was done without attempting to classify the signatures; all differing signatures were delineated. A small number of the resulting polygons were below the general 5 acre minimum, and did not represent the desired special types. These were drawn because they had distinctive photo signatures. Our general philosophy was to delineate what we could see. Stricter adherence to rules for minimum polygon size was paid to washes where minimum width and complexity of anastomosing and branching patterns were considered.

In many cases at the lower elevations a vegetation “signature”, per se, was not discernable because of the extremely sparse desert vegetation and the overriding visible signature of desert landforms. In these cases, following field familiarization with general correlations between landforms and vegetation, polygons were drawn using landforms as a surrogate for vegetation.

Because the delineations were drawn directly on the aerial photographs the resulting shapes were not corrected for spherical distortion. The subsequent steps of scanning and use of computer algorithms corrected this distortion.

Labeling Polygons:

As used here, an “attribute” is a characteristic that describes the vegetation polygons appearing on the on the map. Kari Lewis, Todd Keeler-Wolf, and Cynthia Roye assigned attributes for each of the polygons delineated to represent the vegetation of the park. A total of 20,347 polygons received attributes.



The following attributes were assigned for each polygon:

- **POLYNUM**: a unique number for the individual polygon formed from the number of the photograph plus a number between 1000 and 9999 assigned by computer to the scanned polygons.
- **SERIESFIN**: the vegetation series of each polygon.
- **ASSOC**: the vegetation association, if defined through sampling and analysis.

- **ID**: the method used to determine the vegetation series and association; sample (S), reconnaissance (R), or photo interpretation (P).
- **TOTCOV**: the total cover of vegetation within the polygon. This included cover by the series defining dominant plus all under story vegetation. Three classes of total cover were recognized; low (less than 15 %), medium (15% to 50%), and high (greater than 50%)
- **WHO**: which of the project team members assigned the attributes; Kari Lewis (KL), Todd Keeler-Wolf (TKW), or Cynthia Roye (CLR).

Prior to attribute assignment team members first oriented the photograph to be attributed to a topographic map. The Earthwalk Press, 1994 Anza-Borrego Desert Recreation Map provided enough detail for us to identify topographic features and determine elevation, slope, and aspect. The effective mapping area for each photograph was transcribed onto the topographic map.

Team members then examined of all sample data and reconnaissance information collected from the area depicted by the photograph. Slope, aspect, species composition, and photographs of the sample were of particular importance. Using a key Todd Keeler-Wolf based on the Twinspan analysis of the sample data, team members classified each sample into vegetation series and association, when appropriate. We then classified the polygons which had been the subject of reconnaissance visits. We used similarity of photographic signatures, orientation, and elevation to the samples and reconnaissance to assign series and associations to polygons which had not been visited. The use of association labels in attribution was limited to types which had a distinctive photo signature or a distinctive environmental correlation (for example types that were restricted to washes or terraces). Thus, many polygons were labeled only with their series designation, despite the fact that on-the-ground determinations of their plant association type could have been made.

In areas where we had not taken samples or done reconnaissance, we applied our observations of the position of the vegetation in the landscape gained during the sampling phase, previous field experiences in the unit and other parts of the Sonoran Desert, and consultations with other project staff who had worked in or near the area in question to extrapolate series based on signature, elevation, slope, and aspect of the polygon. To assign attributes in remote areas, we also consulted with State Park staff who are familiar with all or parts of the park. Laurie Archambault, Mark Jorgensen, Paul Jorgensen, and Chris Smith provided particularly helpful insights.

The attribute information was stored in dBase, or Paradox .dbf files to be later merged with the GIS vegetation layer.

Geographic Information System (GIS) Materials and Methods

A Geographic Information System (GIS) was used to produce the digital map depicting the vegetation of Anza Borrego Desert State Park. A GIS is a computerized database designed for the management and use of spatial data. The GIS allows for the development and management of large amounts of information on the location, extent, and characteristics of vegetation over a large geographic area, making it suitable for mapping such a large area as Anza-Borrego Desert State Park.

Overview of GIS Methods:

Vegetation polygons delineated directly on aerial photographs were traced onto a transparent medium and converted to a digital image using a drum scanner. This process resulted in 95 separate images of vegetation polygons, one for each photograph covering the project area. Each digital image was converted to a GIS coverage of lines, or arcs, which was edited using GIS software to create a coverage of vegetation polygons. To reduce distortion inherent to aerial photographs and georeference the polygon coverages, each coverage was registered to known geographic points using SPOT imagery for later transformation to real-world coordinates. Vegetation polygons in each coverage were assigned sequential numerical values for use in assigning vegetation attributes such as vegetation SERIES and ASSOCIATION during the attribution phase. Upon completion of the attribution phase, polygons were re-edited where needed, transformed to the Universal Transverse Mercator (UTM) projection, and mosaicked together to create a seamless vegetation coverage for the entire mapping area. Attributes contained in database (.dbf) files were assigned to the vegetation coverage based on vegetation polygon numbers.

In addition to the vegetation map, a digital map of field data collection points was developed. Global Positioning Systems (GPS) were used during field visits to record exact locations where vegetation sampling occurred. These points were processed using Trimble Navigation software on a personal computer to produce a digital map of most of the areas sampled within the project area.

Hardware and Software:

<u>Hardware</u>

A Hewlett Packard (HP) 9000 Series 700 Model 715 workstation was used for this project with the following configuration:

> HP 9000 series 700 Model 715 workstation with 33 MHz CPU, 96 Mb RAM, and HP-UX 10.2.0
>
> 4.4 GB SCSI internal hard drive
>
> DDS DAT tape drive (4mm)
>
> 19” Color Monitor
>
> Numonics AccuGrid digitizing tablet

The following plotters were used to prepare hard copy vegetation maps:

> Hewlett Packard (HP) DesignJet 750C

HP DesignJet 755 CM

Global Positioning System (GPS) Equipment

Trimble Navigation Pathfinder Basic Global Positioning System (GPS) Receivers (3)
Trimble Navigation GeoExplorer II Global Positioning System (GPS) Receivers (3)

Software

The map was constructed using ARC/INFO software version 7.0.3.

Trimble Navigation Pathfinder Office software version 1.10 was used to process Global Positioning System (GPS) data.

Paradox version 6.0 and DBASEIV database software programs were used to prepare database files used to attribute the vegetation coverage.

Data:

Several data sets were used to construct the vegetation map. The map was developed based on aerial photographs, field investigation, vegetation classification, and GIS processing. In addition, other data sets were used to assist in construction of the vegetation map. These are described below:

Data Provided by Department of Parks and Recreation (DPR)

SPOT Imagery, Thematic Mapper Imagery, and a Merged SPOT/Thematic Mapper Image Product: A 1995 merged SPOT imagery product was generated from georeferenced and terrain-corrected multispectral and panchromatic satellite imagery by California State University San Diego (CSUSD) for DPR. This imagery was used to identify registration points for each of the 95 digital maps to minimize photographic distortion, to georeference the maps, and as a visual backdrop to assist on screen digitizing and quality control.

Topography, Hydrography, Geomorphology: These data sets were used to assist with choosing field sampling sites in different environmental settings within the project area.
Park Boundary: This boundary was used to assist in determination of the project boundary and to produce hard copy maps.

Roads and Trails: The digital map of roads and trails developed by DPR General Plan staff was used for determining access routes to sampling sites.

Palm Data: This data was developed by DPR General Plan staff and depicts the locations of palms in parts of the park. This data was used to quality control occurrences of palm dominated vegetation in the vegetation map.

Elephant Tree Data: This data was developed by DPR General Plan staff and depicts the locations of elephant trees in parts of the park. This data was used to quality control occurrences of elephant tree unique stands in the vegetation map.

Data Developed for the Project by DFG

Project Boundary: This boundary was manually defined as a buffer around the park boundary on aerial photographs, using a map of the park (Earthwalk Press 1994) and a digital coverage of the park boundary as a guide. This boundary was used to determine the acreage of all vegetation types within the project mapping area.

Effective Mapping Area: DFG defined boundaries within which to delineate vegetation polygons on each aerial photograph. This information was used to assist the mosaicking process, and to assist record keeping and quality control.

Field Data Collection Points: These were collected by field staff using Global Positioning Systems (GPS) to record locations of vegetation sampling sites. This information represents the locations of most of the field samples taken during the course of the project. It was used to assist quality control of the vegetation map and to provide more detailed information about visited vegetation polygons.

Field Collected Data: This data was collected by field staff to assist in classification of vegetation within the project area, and labeling of vegetation polygons. This information was used to attribute the coverage of field data collection points and for quality control of the vegetation coverage.

Vegetation Database Files: DFG and DPR staff prepared 95 database files containing attributes of the vegetation coverage. These files were used to assign vegetation codes and other information to the digital map.

Vegetation Crosswalk: The primary vegetation classification for this project is based on *A Manual of California Vegetation* (Sawyer and Keeler-Wolf 1995). The vegetation crosswalk links this classification to other vegetation classifications such as the Holland vegetation classification (Holland 1986), the Wildlife Habitat Relationships (WHR) habitat classification (Mayer and Laudenslayer 1988), the Spolsky vegetation classification (Spolsky 1979), and the National Vegetation Classification (USGS 1997b)

GIS Methods

The following sections describe each stage of GIS processing used to construct the final digital vegetation map.

Georeferencing:

Because aerial photographs provided the foundation for the vegetation map, a process for georeferencing the photographs was needed to minimize photographic distortion and to transform vegetation polygons to real world coordinates. The merged SPOT image product was used to obtain Universal Transverse Mercator (UTM) coordinates for known points on the aerial photographs. A GIS coverage of these control points was constructed from this information and used to transform the vegetation polygons into the UTM projection after scanning and editing phases were complete. Throughout the process of georeferencing, polygons were reviewed against the georeferenced and terrain-corrected merged SPOT imagery to check the quality of the georeferenced polygon coverages. Generally the match was good. In areas where the difference between polygons and the merged image product was found to be 80 meters or greater, control points were reviewed and corrected.

Scanning:

In determining the most effective and efficient way to convert manually drawn vegetation polygons on aerial photographs to a digital vegetation map, the following available methods for digital data capture were considered:

1. digitizing polygons directly from photographs into the GIS using a digitizing tablet
2. digitizing polygons drawn on photographs into the GIS using a mouse and image backdrop (on-screen digitizing)
3. scanning vegetation polygons traced onto a transparent medium into the GIS using a drum scanner to produce a digital raster image
4. scanning photographs into the GIS and transferring vegetation polygons drawn on photographs to the GIS by digitizing on screen.

Method 2 was ruled out, because it was determined that available imagery which could be used for a backdrop did not contain sufficient detail to discern differences in vegetation apparent on the aerial photographs, making the on-screen digitizing process more reliant on interpolation of vegetation lines than was desirable for this project. Method 4 was ruled out for much the same reason. Equipment available to scan aerial photographs did not allow representation of the photographs in sufficient resolution to facilitate accurate on-screen digitizing. Methods 1 and 3 were tested on four photographs, and it was found that the scanning process yielded comparable results to tablet digitizing, but in two-thirds the time.

Based on this pilot investigation, polygons and control points drawn directly on photographs were traced with a mechanical pencil onto acetate polyester, and scanned to produce a digital image of vegetation polygons for each of the 95 aerial photographs in the study area. The scanned images were converted to AutoCAD Exchange Files (.dxf) for transfer into the NHD GIS.

Phase I Editing:

The 95 images of vegetation polygons were converted from AutoCAD Exchange File (.dxf) format to a vector format using the ARC/INFO DXFARC command. This conversion resulted in a vector coverage of arcs defining vegetation polygons for each of the 95 photographs. Because the process of converting a raster image to a vector coverage results in gaps between arcs and overextended arcs, known collectively as dangling nodes, a considerable amount of editing was required to correct these errors. The original tracing of the polygons on acetate polyester was used to guide the corrections. The transparent medium was geographically registered using control points selected during the georeferencing stage, and corrections were performed on the digitizing tablet or on the screen with a mouse using the ARC/INFO module, Arcedit. Each coverage was finalized using CLEAN and BUILD commands in ARC/INFO to yield 95 complete vegetation polygon coverages which collectively encompass the entire project area.

Labeling:

Once the polygon coverages were complete, it was possible to begin assigning vegetation attribute values. To facilitate this, unique numeric values were assigned sequentially to polygons of each coverage. Because the coverages would be merged together to yield a single vegetation map towards the end of the project, it was necessary to devise a numbering system which would provide a unique number for every vegetation polygon in the project area. Using a sequential numbering process in ARC/INFO, polygons were assigned numbers beginning with 1001 and ending with a number greater than 1001 by the total number of polygons in each coverage. For example, if the mapping area covering photograph 2N had 485 polygons, the polygon numbers would start at 1001 and end with 1486. Polygons were numbered this way to provide a consistent number of characters for effortless transfer of attribute data into the GIS. Prior to transferring the data into the GIS, polygon numbers were concatenated with the corresponding photograph number to yield unique polygon numbers across photograph mapping areas, such as 2N1401, and 3N1103.

Once the sequential numbering was complete, transparent overlays of the polygons and polygon numbers were plotted for each photograph. Kari Lewis, Todd Keeler-Wolf, and Cynthia Roye used these overlays with the photographs to assign vegetation attributes to each polygon using the database software programs DBASE4 and Paradox during the attribution phase. Using the polygon number (POLYNUM) as the primary key allowed for future assignment of attributes contained in the vegetation database files to the ARC/INFO GIS vegetation coverage.

Phase II Editing and Transformation:

During the attribution phase, any errors found in the original vegetation polygon coverages were corrected directly on the transparent medium used for attributing and returned to the GIS staff for editing. This editing was performed in a similar manner to the Phase I Editing with the additional step of adding or deleting polygon numbers where necessary. The Phase II Editing also included a quality control process which insured that every polygon was topologically sound and was assigned a unique polygon number. Polygon numbers assigned to field sampling forms were also checked against polygon numbers in the coverages during this phase to insure correspondence between the two data sets. Upon completion of final corrections, the coverages were georeferenced to the ground control points in the UTM 11 projection using the

TRANSFORM command with the projective option in ARC/INFO.

The finalized coverages were georeferenced to the ground control points in the UTM 11 Projection using the TRANSFORM command with the projective option in ARC/INFO.

Mosaicking:

Once the second phase of editing was complete, the 95 vegetation polygon coverages were ready for the mosaicking process. Mosaicking is the process used to join the 95 separate coverages into a single seamless digital vegetation map. This process was performed for adjacent coverages using the MAPJOIN command in ARC/INFO. Maps were joined in groups of four to yield larger "blocks" which were then joined together. Following the issuance of the MAPJOIN command, adjoining coverages were matched along the edges in a process commonly referred to as edge-matching, in which map edges are removed, and adjoining polygons are made continuous with one another. Transparent overlays were used during this process to guide the assignment of polygon numbers which were altered by the GIS after issuance of the MAPJOIN command. Decision rules were developed for the renaming of polygons which spanned two or more photographs. Polygon numbers with corresponding field data were given first preference for labeling altered polygons, followed by polygon numbers associated with the largest portion of single polygons. This was done to insure that the most accurate and representative information would be used to define polygons which span two or more photographs.

Attributing the GIS Vegetation Coverage:

Before vegetation attributes such as SERIES and ASSOCIATION were assigned to the GIS vegetation coverage from the database (.dbf) files created in DBASE 4 and Paradox software, quality control of the database files was performed. First, polygon numbers in the GIS coverage were checked against database files to insure correspondence of polygon numbers for each photograph mapping area. Duplicate and missing polygon numbers were referred to attributers for correction. All records in the vegetation database files were reviewed and invalid codes were corrected. Global Positioning System points collected during field sampling were checked for error in geographic position and reprocessed where needed. The corrected field sampling point data was used together with field data forms to identify and correct any remaining mislabeled polygons.

Following completion of the quality control process, the 95 vegetation database files were placed into a single database file using Paradox software. The single large database file was used with the JOIN command in ARC/INFO to assign attributes to the GIS vegetation coverage. Additional database files containing vegetation crosswalk and map shading information were used to complete the attribution process. The result is a single GIS coverage depicting the location and extent of vegetation in the project area. Detailed technical information about the Anza Borrego Desert State Park digital vegetation map can be found in the Metadata (Appendix 4).

Global Positioning Systems (GPS):

A Global Positioning System (GPS) is a computerized instrument which uses satellite signals to determine its geographic position on the earth. GPS units were used during the field data collection phase of the project to record locations where vegetation sampling occurred. Satellite signals used by the GPS are altered by the Department of Defense, preventing immediate, precise location of geographic position. Therefore, in order to accurately determine the position of a unit on the ground during a given time period, a base station must be used during the time period when GPS units are used. A base station is a GPS unit located at a fixed location which collects satellite data. Using locational data collected in the field along with data from the base station collected from the same time period, and GPS software, it is possible to correct the altered positions of field points to yield accurate information on their geographic position. This process is commonly known as differential correction.

Several GPS readings were collected at each vegetation sampling point. These readings were differentially corrected, and then averaged to provide a single location for each site where field vegetation sampling occurred, accurate to within 5 meters. Using the GPS software, these points were projected into the UTM Zone 11 projection to yield a GIS coverage of most of the locations in which vegetation sampling occurred.

Producing the Hard Copy Maps:

A hard copy map of the entire project area was produced at a scale of 1: 100,000 using the ArcPlot module of ARC/INFO GIS software. This map represents all of the 94 vegetation series described within the mapping area as represented by a total of 20,061 vegetation polygons.

Hard copy maps depicting vegetation of each 7.5' U.S. Geological Survey (USGS) Quadrangle were prepared using the ArcPlot module of ARC/INFO software. The total number of USGS quadrangles for the project area is 35. These quadrangles are listed in the Metadata (Appendix 4).

<u>Results</u>

Classification and Field Guide to the Vegetation Types Mapped in the Anza-Borrego Desert State Park and Environs:

This guide should be sufficient to identify all mappable vegetation types detected in the field work for this project. Identification is by means of a key. The key is not a traditional dichotomous one, but is habitat-based, offering up general choices of different environments based on elevation, topographic position, and physiognomy of the vegetation. Within these general categories, vegetation types are listed by their names and California Natural Diversity Data Base code numbers, with diagnostic characteristics sufficient to separate one from another. This approach was chosen: 1) to reduce the length and redundancy common to dichotomous keys, and 2) because such a guide can be easily mastered by non-botanists/plant ecologists. Our expectation is that this can be a stand-alone product that will allow anyone with some basic ecology background and a knowledge of the main characteristic plant species of the park to identify its vegetation. Our hope is that this guide will afford further refinement to the understanding of vegetation in the park, both from the standpoint of the classification and in refining the accuracy of the existing vegetation map.

In most cases the vegetation types are based on quantitative sampling and analysis using TWINSPAN (Hill 1979). However, other mappable types that were not sampled are included. Some of these unnamed types are unvegetated (wash, mudhills, rock outcrops) and are defined by their physical characteristics. Others (development, recently burned chaparral, mountain meadow) are vegetated, but either botanically complex and too difficult to determine characteristic species from aerial photos, or are unnatural and do not warrant further classification in a vegetation map of natural vegetation. Finally, there is a small group of vegetation types such as Curl-leaf mountain mahogany (*Cercocarpus ledifolius*), White alder (*Alnus rhombifolia*) and Skunkbush (*Rhus trilobata*) that are based on anecdotal information gained from others, or surmised from distinctive photo signatures, and not actually observed in the field work for this map.

The key is first broken into two major units based on elevation: 1) vegetation of the chaparral, montane woodlands, juniper and pinyon woodlands, and the "high desert" vegetation with Mojave yucca (*Yucca schidigera*) and blackbush (*Coleogyne ramossisima)*, and 2) vegetation of the lower elevation desert and alkaline wetlands. Thus, the latter unit of the key is essentially a guide to the portion of the park within the Colorado Desert, while the second unit describes the Peninsular Range vegetation of the park including the montane and cismontane types as well as the upper desert.

This guide is based on general ecological settings born out in the TWINSPAN analysis of approximately 500 vegetation samples and divides the vegetation into each group using characteristic species and their abundances. The two main divisions reflect the dichotomy in the TWINSPAN classification. The first major split in TWINSPAN was to segregate the upper and lower elevation vegetation types. Further subdivisions within the upper elevation subunits also reflect the TWINSPAN classification at lower levels of the classification. The lower elevation subunits are more artificial and do not always reflect the TWINSPAN analysis. However, descriptions of individual series and associations do reflect the fine scale clustering of like samples through the analysis.

Within each group, vegetation types are listed by their series and association. A series is a floristically defined unit of vegetation characterized by one or more dominant species. An association is a sub-floristic unit of a series defined by characteristic species (not necessarily dominant) restricted to an environmental subset of the range of a series. Both series and the associations within them are defined quantitatively via vegetation sampling. (See Sawyer and Keeler-Wolf 1995 for further description of these classification units). In some cases associations are not defined for a series and just the series name is listed (see classification section for discussion). Often a particular vegetation series or association may occur in multiple groups. Each major group within the two elevation zones should include all possible types identified within it. Descriptions are brief and restricted to salient individuating features. Complete descriptions of associated species and ecological settings will be published as separate findings and will be included in the next edition of the Manual of California Vegetation.

In using this as a field guide it should be kept in mind that this is a key to vegetation mapping polygons, not necessarily to vegetation types. It was devised with the map in mind. The general question of whether an area meets the criteria should be assessed using the entire polygon. In some cases polygons have some substantial internal variation, thus an averaging approach, estimating the modal vegetation within a polygon should be invoked. Some polygons are unvegetated types, which are given codes based on their physiognomy. To assign polygons to a vegetation type run through appropriate general category, then choose the most appropriate category listed. If no association is listed go with the closest series type. Following this key is a summary table (Table 1) which depicts the relationships within and between the groupings.

To use this guide without reference to the vegetation map, one should keep in mind the constraints of minimum mapping unit (mmu). In general, vegetation stands of upland types were not delineated below 5 acres in size and wetland/wash/riparian types were not delineated below 1 acre (please see delineation section for further details). In some cases dominance must be averaged over the entire polygon and in all cases nominate species for a series must be evenly distributed over a stand to assign it to the nominate species series. For example, in a low elevation wash there may be a concentration of smoketree in a ½ acre area where the cover is; smoketree 20% over a under story of cheesebush at 15%. However, over the majority of the surrounding 5 acre polygon the wash is; cheesebush 15% and smoketree 1%. Because the smoketree area of dominance is below the minimum mapping unit, the whole area would be properly considered a cheesebush series map polygon. In this same vein there are many small stands, especially wetland and herbaceous vegetation, that have not been seen to reach mappable size in the study area. Thus, these fine-scale types are not included in the guide and are absorbed by the larger adjacent stands in the map.

<u>DIVISION A.</u> Vegetation below the zone of sugarbush (*Rhus ovata,)* Mojave yucca (*Yucca schidigera)*, and California juniper *(Juniperus californica)*. Any stands with the above species in any significant component (1% or greater cover) will not be identified here and should be sought in <u>Division B</u>.
The following general categories are used:
1. Low elevation desert washes and arroyos (including unvegetated sandy to cobbly wash bottom). These include wash terraces adjacent to the wash.
2. Low elevation playas, depressions and alkaline soils
3. Low elevation wetlands and riparian
4. Low elevation uplands (bajadas, hills, pediments, and mountain slopes) including unvegetated rock outcrops and colluvium

<u>Group I</u>: Low elevation desert washes, arroyos, and terraces immediately above washes, not including more permanent intermittent streams or springs with riparian vegetation dominated by willow (*Salix sp.)*, cottonwood (*Populus sp.)*, fan palm (*Washingtonia)*, or

sycamore (*Platanus*) :

A. Trees or large shrubs of mesquite (including honey mesquite *Prosopis julifolia torreyana* and/or screwbean, *P. pubescens)* ironwood (*Olneya tesota),* blue palo verde (*Cercidium floridum*), smoketree *(Psorthamnus spinosus*), desert willlow (*Chilopsis linearis*), or tamarisk (*Tamarix* spp.) present:

not as above: B

A1. Total mesquite cover (including shrub and trees together) greater than 3% in any single stand and not exceeded by any other species of microphyllous tall shrub or tree. = **Mesquite series (61510.00)**

a. Associated species include typical lower desert wash species such as sweetbush (*Bebbia juncea*), sandpaper plant (*Petalonyx thurberi*), smoketree, and cheesebush (*Hymenoclea salsola*) Widespread throughout lower elevation washes and edges of riparian areas of park up to 3000 ft. = **Mesquite wash association 61510.02**

A2. Total ironwood (*Olneya tesota*) cover, including shrub and trees together, greater than 3% in any single stand and not exceeded by any other species of microphyllous tall shrub or tree. Largely restricted to vicinity of San Felipe Creek (Yaqui Well and downstream), Harper Wash and nearby washes west of Ocotillo Wells. Note: Ironwood stands outside of washes on adjacent bajadas or lower slopes of hills (Harper Canyon mouth) may be keyed (see C). = **Ironwood series 61560.00 (no associations defined)**

A3. Total blue palo verde (*Cercidium floridum*) cover including shrub and trees together, greater than 3% in any single stand and not exceeded by any other species of microphyllous tall shrub or tree. Largely restricted to the northeastern portion of the park = **Blue palo verde series 61540.00 (no associations defined)**

A4. Total smoketree (*Psorothamnus spinosus*) cover (including shrub and trees together) greater than 3% in any single stand and not exceeded by any other species of microphyllous tall shrub or tree. Widespread throughout lower elevation of park up to about 2000 ft. = **Smoketree series 61570.00 (no associations defined)**

A5. Total desert willow (*Chilopsis linearis*) cover (including shrub and trees together) greater than 3% in any single stand and not exceeded by any other species of microphyllous tall shrub or tree, scattered throughout park mostly between 1000-2500 ft, but occasionally as low as 100 ft. and as high as 2800ft. = **Desert willow series 61550.00 (no associations defined)**

A6. Total catclaw (*Acacia greggii*) cover, including shrub and trees together, greater than 3% in any single stand and not exceeded by any other species of microphyllous tall shrub or tree = **Catclaw series (33040.00)**

a. Catclaw principal large shrub restricted to margins or channels of washes and arroyos associated below ca 2800 ft. with other wash species such as desert lavender, cheesebush, sweetbush, and chuparosa (*Justicia californica*) **= Catclaw wash association 33040.01**

A7. Total tamarisk (*Tamarix* spp.) including shrub and trees together, greater than 3% in any single stand and not exceeded by any other species of microphyllous tall shrub or tree = **Tamarisk series (63810.00)**

a. in general, all tamarisk types found adjacent to washes in the park are shrub tamarisk association dominated by either *Tamarix chinensis, ramossisima* or *gallica* (all lumped here). Active removal has reduced stands in Coyote Cr, San Felipe Cr, Fish Cr., and other drainages since 1992 air photos. Thus, areas mapped as this type may be larger than current extent. Largest existing stands are in Carrizo Marsh, upper Carrizo Cr., and Canebreak Canyon = **Shrub tamarisk association 63810.02**

A8. Smoketree, ironwood, and/or Palo verde form near equal cover in a wash. May also include significant desert willow. Rare in the park (San Felipe Cr. below Tamarisk Campground) , much more common in Coachella Valley and SE of Salton Sea. = **Ironwood-Smoketree-blue palo verde series 61530.00**

B. Dominant layer is composed of shrubs. No significant cover of microphyll trees or big shrubs exceeding 3 m, although may include species such as desert lavender (*Hyptis emoryi)* and creosote bush (*Larrea tridentata)* which occasionally exceed 3 m, they are generally less robust than above species:

Not as above: C (page 5)

B1. Desert lavender *(Hyptis emoryi*) covers >5% of a single stand and exceeds any other shrub in cover. Widespread in washes and narrow arroyos and canyons below 2000 ft. = **Desert Lavender series 33190.00 (no associations defined)**

B2. Cheesebush (*Hymenoclea salsola*) covers > 5% of a single stand and exceeds any other shrub in cover (may include up to 3% desert lavender and smoketree) = **Cheesebush series (33200.00)**

a. washes and disturbed areas on bajadas below about 2000 ft. Widespread. = **cheesebush wash association 33200.01**

B3. Allscale (*Atriplex polycarpa)* covers > 3% of a single stand and exceeds any other shrub in cover. Scattered along broader washes and on adjacent terraces below 2500 ft. throughout park = **Allscale series 36340.00 (no associations defined)**

B4. *Baccharis emoryi* covers > 3% of a single stand and exceeds any other shrub in cover. Uncommon; usually small stands on margins of active washes such as Fish Creek

= ***Baccharis emoryi* series 63520.00 (no associations defined)**

B5. Burrobush *(Ambrosia dumosa*) covers > 3% of a single stand and exceeds any other shrub in cover = **Burrobush series (33060.00)**

a. burrobush terrace stands adjacent to medium to large washes on east side of park (e.g., Fish and lower Carrizo Crs.) generally with some scattered mesquite, *Atriplex* spp., and *Lycium brevipes* , **burrobush terrace association 33060.02**

B6. Desert agave (*Agave deserti*) covers >5% of stand and exceeds any other woody species in cover= **Agave series (33075.00).**

a. stands dominated by Agave on islands, alluvial fans, and terraces in and adjacent to washes widespread below ca. 2400 ft. = **Agave wash and terrace association 33075.01**

B7. Creosote bush (*Larrea tridentata)* is >5% and exceeds any other shrub in cover = **Creosote bush series (33010.00)**

a. stands are in low gradient washes flowing across gentle bajadas and in upper valleys (e.g, The Potrero, Carrizo Cr.) and do not include significant burrobush, but may have scattered mesquite, smoketree or desert willow. Creosote bush typically reaches "tree" size (>3m) = **Creosote bush wash association 33010.06**

b. Creosote bush and allscale (*Atriplex polycarpa*) are main species; terraces adjacent to large washes such as San Felipe, Valliceto, and Carrizo creeks (see same for alkaline areas) = **Creosote bush-allscale association 33010.05**

B8. Stands dominated by a +- equal mixture of creosote bush (*Larrea tridentata*) and burrobush (*Ambrosia dumosa*). Both evenly distributed in stand, at least 1% cover, neither species exceeding x the cover of the other, and no other species greatly exceeding either of these species in cover) **= Creosote bush - burrobush series 33140.00**

a. *Psorothamnus emoryi* and *Croton californica* present (may be less than 1% cover) creosote and burrobush in relatively low cover , the invasive annual *Brassica tournefortii* usually common. Occurs at edges of sandy washes, and shallow blowsand areas throughout much of lower elevation area of park. = **Creosote bush-burrobush -sandy association 33140.07**

C. no significant cover of any woody perennial species:

C1. ground is covered by less than 2% vegetation, restricted to active wash channels throughout park **= sandy to cobbly wash bottom 99900.01**

C2. ground is covered by sparse to dense cover of saltgrass (*Distichis spicata)* stands rarely large enough to be mappable except for along Carrizo and Coyote Canyon washes**= saltgrass series 41200.00 (no associations defined)**

<u>GROUP II</u>: Alkali and Saline Areas around Playas and Depressions; including flats and some broad alluvial terraces adjacent to larger washes

A. Shrub-dominated vegetation

not as above: B

A1. Bush seepweed (*Suaeda moquinii*) covers over 3% of stand and exceeds any other shrub in cover. Largest stands near Clark Dry Lake, others near alkaline springs in Carrizo Cr. draninage, and near Halfhill Dry Lake = **Bush seepweed series 36220.00 (no associations defined)**

A2. Iodine bush (*Allenrolfea occidentalis*) covers over 3% of stand and exceeds any other shrub in cover. Uncommon, small stands adjacent to Clark Dry Lake and lower Carrizo Cr, near Carrizo Marsh= **Iodine bush series 36120.00 (no associations defined)**

A3. Mesquite (including honey mesquite, *Prosopis julifolia torreyana* and/or screwbean, *P. pubescens)* covers 3% or more of the stand = **Mesquite series 61510.00**

a. the common form of mesquite series around edges of Clark Dry Lake, Borrego Sink, and major wetlands adjacent to low elevation washes such as Carrizo Marsh and Middle and Lower Willows may occur as scattered hummocks with *Atriplex* spp. scrub between or as denser thickets = **Mesquite alkaline association 61510.03**

A4. Allscale *(Atriplex polycarpa*) covers > 3% of a single stand and exceeds any other shrub in cover. Similar to stands of this series adjacent to washes, but stands as at Palm Spring, and above Clark Dry Lake are not associated with washes = **Allscale series 36340.00 (no associations defined)**

A5. Four-wing saltbush (*Atriplex canescens*) clearly dominant . Occasional small stands as adjacent to playas in Earthquake and Little Blair Valleys, most stands at lower elevations are below minimum mapping unit.= **Fourwing saltbush series 36310.00 (no associations defined)**

A6. Two or more saltbush species present (typically *Atriplex polycarpa* is dominant with, *A. canescens* and *A. lentiformis* less common), together forming the dominant shrub cover, each *Atriplex* averaging > 20% relative cover. Uncommon; usually small stands adjacent to large mesquite thickets as at Butterfield Stage, Vallecito Stage, and lower Willows = **Mixed saltbush series 36360.00 (no associations defined)**

A7. Creosote bush (*Larrea tridentata)* is >5% and exceeds any other shrub in cover = **Creosote bush series (33010.00),**

a. usually with relatively high cover of allscale (*Atriplex polycarpa*). Similar to stands adjacent to washes, but these often more extensive as at Lower Carrizo Cr.

= **Creosote bush - Allscale association 33010.05**

B. Shrubs not dominant:

B1. The non-native grass *Schismus barbatus* dominant **series 42090.00**
a. occurs on silty and clay flats and playas of relatively low alkalinity particularly Blair and Earthquake valley playas, often with the non native grass *Bromus madritensis rubens* and native herb *Hoffmannseggia glauca* present , very low shrub cover includes scattered mesquite and four-wing saltbush (*Atriplex canescens)*, = ***Schismus* playa association 42090.01**

B2. Vegetation cover insignificant, playa bed as at Clark Dry Lake **= Unvegetated Playa 9990.08**

GROUP III: Low elevation springs and permanent wetlands generally below 2500 ft. elevation (does not include any stands dominated by willows or cottonwoods)

A. Shrub or tree-dominated vegetation

not as above: B

A1. A tamarisk species dominant = **Tamarisk series 63810.00**
a. Athel, a non-native tree (*Tamarix aphylla*) dominant ; rarely self colonizing (planted groves as at Tamarisk campground, Ocotillo Wells) = ***Tamarix aphylla* type 63810.01**

b. shrubby *Tamarix*, either *T. chinensis*, *ramossisima* or *gallica* (all lumped here) dominant, often self colonizing and a troublesome invading community as at Carrizo Marsh, Carrizo Gorge, Canebrake Canyon = **shrub tamarisk type 63810.02**

A2. Desert Fan Palm (*Washingtonia filifera)* 3% or greater cover may be mixed with other riparian trees = **Desert Fan Palm Series 61520.00**
a. associated species often alkaline adapted (*Atriplex* spp., *Baccharis emoryi*, *Pluchea sericea*), this includes all palm stands in and adjacent to mudhills and badlands as well as springs such as Mountain Palm Spring. Note: the palm stands identified in this vegetation map will not match all palms located by GPS by Anza-Borrego General Plan staff. Stands shown on the map are composed of multiple individuals and are generally> 1 acre in size, unlike the GPS'ed palms which were often individuals isolated from most of the well known stands = **desert fan palm spring type 61520.02**

A3. Mesquite (including honey mesquite, *Prosopis julifolia torreyana* and/or screwbean, *P. pubescens)* dominant (>3%) **= Mesquite series (61510.00)**
a. generally associated with arrowweed (*Pluchea sericea)*, bush seepweed

(Suaeda moquinii), saltbush (*Atriplex* spp.). Occurs at springs adjacent to mud hills and badlands as at Palm Spring= **Mesquite alkaline spring type 61510.06**

B. Shrubs not dominant:

B1. permanent wetland vegetation dominated by bulrushes (*Scirpus* sp.) = **Bulrush series 52101.00**

a. vegetation dominated by California bulrush, most stands below minimum mapping unit as at Sentenac Cienega = **California bulrush association 52101.01**

b. vegetation dominated by threesquare (*Scirpus americanus*) occasionally large enough for mapping as at Sentenac Cienega = **Threesquare association 52101.02**

B2. permanent wetland vegetation dominated by cattails (*Typha* sp.) generally not large enough for minimum mapping unit, but does occur at many low and mid-elevation springs and other wetlands **= Cattail Series 52103.00 (no associations defined)**

GROUP IV: Low Elevation Uplands (includes all vegetation on hills, mountains, alluvial fans, and bajadas away from active washes):

A. stands dominated by shrubs:

not as above: B

A1. Stands dominated by a +- equal mixture of creosote bush (*Larrea tridentata*) and burrobush (*Ambrosia dumosa*). Both evenly distributed in stand, each at least 1% cover, neither species exceeding 2x the cover of the other, and no other species greatly exceeding creosote or burrobush in cover) **= Creosote bush - burrobush series** (**33140.00)**

a. *Larrea-Ambrosia* co-dominant but with indigobush (*Psorothamnus schottii*) as third major species, often in equal importance. Widespread throughout bajadas and fans and on lower slopes throughout park = **Creosote bush-burrobush-indigo bush association 33140.06**

b. *Psorothamnus emoryi* and *Croton californica* present (may be less than 1% cover) , creosote and burrobush in relatively low cover , the invasive annual *Brassica tournefortii* usually common, occurs at edges of sandy washes, and shallow blowsand areas throughout much of lower elevation area of park = **Creosote bush-burrobush -sandy association 33140.07**

c. Desert holly (*Atriplex hymenolytra)* 1% or greater with sparse *Larrea tridentata* and *Ambrosia dumosa*, usually steep fanglomerate, oyster beds, and eroded granitic sediments of eastern part of park = **Creosote bush-burrobush-desert holly association 33140.08**

d. Creosote bush and burrobush in even mix but with diverse addition of species such as Agave, *Galium angustifolium, Lyrocarpa coulteri, Ephedra nevadensis,* *Viguiera parishii*, etc. Occurs on N and E-facing slopes on granite between 1000 and 2000 ft. = **Creosote bush-burrobush -bedstraw-*Lyrocarpa* association 33140.09**

A2. Stands dominated by creosote bush in upper shrub layer without burrobush as the major subshrub **= Creosote bush Series (33010.00)**

a. Creosote bush and the subshrub brittlebush (*Encelia farinosa*) in +- equal abundance (both 1% or greater cover) with no other woody species greatly exceeding them in cover. May include burrobush and succulents (*Opuntia* sp., *Agave*) and emergent ocotillo, but ocotillo never >5% and brittlebush never exceeded by burrobush in subshrub layer. Widespread throughout lower elevation hills and lower mountains, largely on coarse granitic substrates particularly in northern half of park **= Creosote bush - Brittlebush association 33010.04**

A3. Burrobush major woody species with only scattered emergent shrubs (no species >1%), at least 2x more cover than creosote bush and exceeds cover of any other subshrubs such as brittlebush (*Encelia farinosa*) = **Burrobush series (33060.00)** (note: the typical upland expression of this series is widespread as on the hills south of Valliceto Stage station, North-facing slopes of Volcanic Hills, and on bajadas on eastern edge of park. However, more sampling is needed to subdivide into associations, see wash types for the terrace association and below for an upper desert association)

a. burrobush co-dominant with deerweed (*Lotus scoparius),* goldenhead *(Acamptopappus sphaerocephalus)*, and big galleta grass (*Pleuraphis rigida*). Occurs at edges of The Potrero, Indian Valley, and other upper desert bajadas and fans between 1400 and 2500 ft. = **Burrobush - goldenhead association 33060.01**

A4. Stands dominated by brittlebush (*Encelia farinosa*), other tall shrubs less than 5% cover and no single tall shrub> 5%. Brittlebush is at least a 5% if creosote bush or burrobush is 1-4% cover **= Brittlebush series (33030.00)**

a. Brittlebush mixed with relatively high cover of succulents (including varying combinations of *Opuntia bigloveii, O. echinocarpa, O. acanthocarpa, Echincereus engelmannii, Ferocactus cylindraceus*, Agave and scatted emergent ocotillo), but not exceeded by any of them in cover. Widespread throughout lower elevation se , s and sw- facing exposures particularly on coarse granitic substrates, but not with numerous large rocks and boulders = **Brittlebush succulent association 33030.01**

b. Brittlebush dominant usually associated with Creosote bush and burrobush. Desert Fir (*Peucephyllum schottii*) at least 1% cover and evenly distributed over the polygon. Often on volcanics such as Volcanic Hills in southern portion of park = **brittlebush - desert fir association 33030.02**

A5. Stands with a consistent cover of about 5% or greater emergent ocotillo (*Fouquieria splendens*) over otherwise typical Creosote bush -burrobush series or Creosote bush - brittlebush vegetation. Usually on low hills or upper fans and bajadas below 1500 ft.

scattered throughout park as at Ocotillo Flat, Dos Cabesas, Dolomite Mine Rd. **= Ocotillo series 33090.00 (no associations defined)**

A6. Stands with 5% or greater of *Opuntia bigloveii* with no other species surpassing it in cover (includes as part of series stands dominated by stable hybrids such as *O.* X *fosbergii*). Typically on course alluvium of upper fans and bajadas, or lower hills without numerous large rocks and boulders; scattered throughout park (Cactus Valley, Cactus Loop Trail, Mason Valley, hills N of Valliceto Stage Station) occasionally as high as 2800 ft.= **Teddybear Cholla series 33050.00 (no associations defined)**

A7. Dominant species is the low subshrub *Fagonia laevis*: Stands without more than 1% of any larger shrubs or subshrubs including: *Ambrosia*, *Larrea*, *Encelia*. Restricted to hot, very dry slopes of park (mostly eastern part as near Split Mtn.) at low elevations below 1200 ft. = **Fagonia series 33061.00 (no associations defined)**

A8. Stands with elephant tree (*Bursera microphylla*) present as an emergent overstory of 3-10% cover. Rare and scattered (only 3 mappable stands, Torote Cyn, Starfish Cove, Santa Rosa Mtns), largely on steep south-facing exposures on granitics below 1800 ft. Note: other populations of this species exist in the park, but are not dense enough or large enough to be considered mappable.
= **Elephant tree unique stands 33120.00 (no associations defined)**

A9. Stands dominated by *Caesalpinia virgata* (*Hoffmannseggia microphylla* in Munz), Rare on sterile badlands and adjacent rocky slopes of low hills primarily in Carrizo Creek drainage (e.g., Red Rock Canyon, Canyon Sin Nombre) **= *Caesalpinia virgata* unique stands 33062.00**

A10. Desert agave (*Agave deserti*) covers >5% of stand and exceeds any other woody species in cover (note: occasional stands dominated by Agave occur on steep to moderately steep hills below 2000 ft. as in upper Harper Canyon vicinity of Mescal Bajada, etc., the few samples appear too variable to assign to one association. Except for high Agave cover, these stands bear close similarities to stands assigned to upland burrobush, brittlebush, and creosote-brittlebush types) = **Agave series 33075.00**

B. Stands not dominated by woody species, any perennial vegetation less than 3% cover total:

not as above: C

B1. Very sparsely vegetated hills of white to muddy gypsum (only near Split Mountain) only plants are scattered *Argemone munitum, Nicotiana, Peucephyllum*, and annual eriogonums = **gypsum association 99900.02**

B2. Very sparsely vegetated mud hills and badlands composed of silty clay material, annual herbs scattered especially *Eriogonum trichopes*, no shrubs in significant cover =

mud hills association 99900.03

B3. rocks and cliff faces with little vegetation, mostly very steep = **low elevation rock outcrop 99900.04**

B4. Area covered by sand with no significant vegetation = **active dunes and sand fields 22010.00**

B5. The polygon is a parking lot, building, agriculture, or other human clearing. May have some vegetation, but typically non-native (e.g., garden or crop) = **development 99900.06**

B6. The polygon is a dry lake bed (playa) = **Unvegetated Playa 99900.07**

C. stands dominated by trees:

C1. Total ironwood (*Olneya tesota*) cover including shrub and trees together greater than 3% in any single stand and not exceeded by any other species of microphyllous tall shrub or tree (note ironwood stands outside of washes on adjacent bajadas (Harper Wash mouth) may be keyed here) = **Ironwood series 61560.00**

<u>Division B.</u> **Vegetation of the upper elevations including and above the zones of species such as sugarbush (*Rhus ovata*), Mojave yucca (*Yucca schidigera*), and California juniper (*Juniperus californica*). Includes chaparral, montane woodlands, juniper and pinyon woodlands, and upper desert vegetation of the park.**

The following general categories are used:

1. Upper Elevation Riparian, Springs, Meadows, and Seeps (includes all hydrophilic vegetation associated with flowing water or saturated soil)
2. Upper Elevation Montane Woodlands (trees over 3 m tall are the visual dominant)
3. Upper Elevation Dense Chaparral (sclerophyllous scrub is strongly dominant)
4. Desert Transition Scrub (Mixed sclerophyll scrub and drought-deciduous sub-shrub scrub)
5. Desert Upland Scrub Vegetation (vegetation dominated by desert shrubs and sub-shrubs)
6. Grassland (grasses form a canopy of at least 25% cover with an over story of trees or shrubs, if present, of 5% or less)
7. Unvegetated areas (total vegetation is less than 3% cover)

<u>Group I</u>**: Upper Elevation Riparian, Springs and Seeps. Vegetation dominated by trees and large shrubs:**

A. Stands dominated by trees and large shrubs:

Not as above: B

A1. Arroyo willow *(Salix lasiolepis*) dominant. Widespread from about 1200 to above 5000 ft. stands vary in species composition from desert springs to montane riparian settings, most stands are < 1 acre= **Arroyo willow series 61201.00 (no associations defined)**

A2. Narrow-leaf willow *(Salix exigua*) dominant. Stands are small and occur at springs and along +- permanent creeks, generally between 1200 and 4000 ft. = **Narrow-leaf willow series 63110.00 (no associations defined)**

A3. Mesquite including honey mesquite, *Prosopis julifolia torreyana* and/or screwbean, *P. pubescens,* dominant (>3%) **= Mesquite series 61510.00**

> **a.** Stands are a mix of mesquite and willows (largely *Salix exigua,* and *S. lasiolepis,* but also *S. laevigata, S. gooddingii,* and others), generally mesquite accounts for more cover. Widespread adjacent to many of the main wetlands in the park including Sentenac Canyon, Upper and Middle Willows, etc. **mesquite-willow association 61510.07**
>
> **b.** *Prosopis glandulosa* with sugarbush (*Rhus ovata)* and other large shrubs of upper desert, generally associated with hillside springs above 2500 ft. = **Upper desert mesquite spring association 61510.08**

A4. Mulefat (*Baccharis salicifolia*) dominant, scattered as small stands associated with springs and riparian stringers above 3000 ft., most extensive at Sentenac Cienega = **Mulefat Series 63510.00 (no associations defined)**

A5. Broom baccharis (*Baccharis sergiloides*) dominant; ephemeral stream channels of mid- and upper elevations. Relatively uncommon as in McCain Valley area. Most stands are below minimum map unit = **Broom Baccharis series 63530.00 (no associations defined)**

A6. Arrowweed (*Pluchea sericea*) dominant; generally monospecific thickets associated with alkaline springs or borders of riparian or marsh situations. Most stands are below minimum map unit = **Arroweed series 63710.00 (no associations defined)**

A7. Fremont cottonwood (*Populus fremontii*) dominant **= Fremont cottonwood series (61130.000**

> **a. Fremont cottonwood emergent** with mesquite as major small tree or shrub. occasional around springs below 3000 ft. (Cottonwood Valley, Mason Valley)**= Fremont cottonwood- mesquite association 61130.06**

A8. Desert fan Palm (*Washingtonia filifera*) >3% cover = **Fan Palm series 61520.00**

> **a.** Palms associated with other riparian species such as sycamore (*Platanus racemosa*), and willows (*Salix* spp.). This is the standard palm association of the riparian canyon settings as at Borrego Palm, Hellhole, and Sheep canyons. Note: the palm stands identified in this vegetation map will not match all palms located

by GPS by Anza-Borrego General Plan staff. Stands shown on the map are composed of multiple individuals and are generally > 1 acre in size, unlike the GPS'ed palms which were often individuals isolated from most of the well known stands = **Fan Palm-Sycamore association 61520.03**

A9. Desert willow (*Chilopsis linearis*) principal large shrub in riparian or wash setting (e.g, Grapevine Cyn)**= Desert Willow series 61550.00**

A10. California sycamore (*Platanus racemosa*) dominant. Generally small stands along permanent creeks in northwestern portion of park (Hellhole, Borrego, Oriflamme, Banner) = **Sycamore Series 61310.00**

A11. White alder (*Alnus rhombifolia*) dominant, forming dense stream side stands in a few canyons in northwestern corner of mapping area (e.g., both Alder Canyons) = **White alder series 61420.00 (no associations defined)**

A12. Catclaw (*Acacia greggii*) dominant large shrub over varied sub-shrub or grass layers **= Catclaw series (33040.00)**

a. Catclaw principal large shrub in riparian or wash setting below ca 2800 ft. with other wash species such as desert lavender, cheesebush, sweetbush, and chuparosa (*Justicia californica*). Widespread throughout park. **= Catclaw wash association 33040.01**

A13. Quailbush (*Atriplex lentiformis*) dominant often with alkali sacaton (*Sporobolus airoides*) in under story. Local especially in Dubber Springs - Jacumba Valley area **= Quailbush Series 36370.00**

B. Stands dominated by herbaceous species:

B1. Stands dominated by the stoloniferous Mexican rush (*Juncus mexicanus*). Generally occurs in meadows at elevations above 4000 ft. As in McCain, Lost, and Thing valleys. Most stands are too small to be mapped. Reconnaissance only, no samples were taken in this vegetation = **Mexican Rush series 45500.00**

B2. Stands dominated by a diverse mixture of mesophyllic to hydrophyllic species including grasses, sedges, rushes and forbs. Most stands are above 4000 ft. As at Lost Valley and Lucky Five Ranch, most are below minimum mapping unit = **Montane Meadow habitat (4531000)**

<u>Group II:</u> Upper Elevation Montane Forests and Woodlands (including dwarf woodlands such as Pinyon pine and Curl-leaf Mountain Mahogany)

A. Vegetation of Montane or Coastal Affinities

A1. Coast live oak (*Quercus agrifolia*) dominant tree **= Coast Live Oak Series 71060.00**

a. Coast live oak in dense woodland of low lying areas; under story dominated by Wright's buckwheat (*Eriogonum wrightii membranaceum*) and diverse native herbs. Lost Valley-Los Coyote area, and locally in Laguna Mtn. area **= Coast live oak/Wright's buckwheat association 71060.21**

b. Coast live oak and Coulter pine (*Pinus coulteri*) codominant, occurs in Lost Valley area in valley bottoms usually surrounded by chaparral**= Coast Live oak - Coulter Pine association 71060.22**

A2. Canyon live oak (*Quercus chrysolepis)* dominant. Local at upper elevations > 4000 ft. May be large shrubs in fire-prone areas (Laguna Mountains escarpment) or tree-sized stands with diverse herbaceous under story of montane affinities (north slope of Combs Peak)**= Canyon live oak series 71050.00 (no associations defined)**

A3. California bay (*Umbellularia californica)* dominates usually in small steep ravine stands > 4000 ft. Local, mostly in upper Oriflamme Canyon and Laguna Mountains escarpment area= **California Bay series 74100.00**

A4. Jeffrey pine (*Pinus jeffreyi*) is principal overstory tree forming open to dense canopy. Local on west side of mapping area near Sunrise Highway and Mt. Laguna = **Jeffrey Pine series (87020.00)**

a. Jeffrey pine and California black oak (*Quercus kelloggii*) main canopy species (trees > 5% cover). The typical pine-oak woodland of the Mt. Laguna region, barely reaching the western edge of the mapping area **= Jeffrey Pine-California black oak association 87020.24**

A5. California black oak (*Quercus kelloggii*) dominant small or large tree. Near Sunrise Highway and Mt. Laguna usually associated with chaparral species as small resprout stands, more extensive and mature stands near Lost Valley and Los Coyotes = **California black oak series 71010.00 (no associations defined)**

A6. Coulter pine (*Pinus coulteri*) dominant; trees > 5% cover over chaparral species, usually above 4000 ft , most common in NW corner near Combs Peak, Lost Valley, Los Coyotes. largest stands associated with pink-bract manzanita (*Arctostaphylos pringlei*) chaparral = **Coulter Pine series 87090.00 (no associations defined)**

A7. Coulter pine and canyon live oak (*Quercus chrysolepis*) co-dominant. At highest elevations in the northwestern portion of park near Combs Pk. and Los Coyotes, extensive stands near Hot Springs Mtn. = **Coulter Pine- canyon live oak series 87210.00**

A8. Parry pinyon pine (*Pinus quadrifolia*) present and conspicuous (often only 3-5% cover over other chaparral shrubs, or with scattered *Quercus chrysolepis*) rare on Mt. Laguna escarpment between Monument Pk. and N-facing slopes above Potrero Wash. (note: scattered individuals of *P. quadrifolia* occur over chamise-redshank chaparral at head of Nance Canyon in NW corner of mapping area, but do not constitute enough cover to define series)**= Parry (or Four-needle) Pinyon Pine series 87030.00**

B. Vegetation of Desert Affinities

B1. Single-leaf pinyon (*Pinus monophylla*) dominant tree over varied under story, at least 5% cover, *P. monophylla* taller and more conspicuous than any other species. Occurs as largest stands on Pinyon Mountain and on Santa Rosa Mtns. near Villager Pk. Smaller isolated stands occur in upper Coyote Canyon (e.g., upper White Wash, Buck Ridge) and on the southeast slopes of Granite Mtn. Isolated trees occur in desert chaparral on Pinyon Ridge and far to the south on Jacumba Mtns., but do not constitute enough cover for series definition **= Single-leaf pinyon pine series 87040.00 (no associations defined)**

B2. Curl-leaf mountain mahogany (*Cercocarpus ledifolius*) dominant. Rare in mapping area, restricted to upper dry slopes of Santa Rosa Mountains in vicinity of Villager Pk. = **Curl-leaf Mountain Mahogany series 76200.00 (no associations defined)**

<u>Group III:</u> **Upper Elevation Dense Chaparral; vegetation strongly dominated by evergreen sclerophyll shrubs or by typical chaparral genera that may be winter deciduous (*Ceanothus, Rhus*)**

A. Vegetation dominated by evergreen broad or needle-leaf chaparral species

Not as above: B

A1. Chamise *(Adenostoma fasciculatum*) dominant; 50% or more relative cover. Widespread chaparral type extremely variable in cover and in composition. Typical form is almost monospecific dense shrub cover, but ranges to edges of desert as in Mason Valley, upper Coyote Canyon, and lower Oriflamme Canyon where mixed with *Eriogonum fasciculatum, Salvia apiana, Prunus fremontii, Viguiera parishii,* etc. Insufficient sampling to individuate further related series such as chamise-white sage, or chamise-bigberry manzanita. This is a somewhat broader definition than is in Sawyer and Keeler-Wolf (1995) = **Chamise series 37100.00 (no associations defined)**

A2. Chamise and Eastwood manzanita (*Arctostaphylos glandulosa*) co-dominant; both species at least 30% relative cover and both exceed any other species in cover. This is an upper elevation chaparral found largely above 4200 ft. as at upper Oriflamme Cyn, and ridge east of Thing Valley. **= Chamise-Eastwood Manzanita series 37106.00 (no associations defined)**

A3. Chamise and cupleaf ceanothus (*Ceanothus greggii*) are both 30-60% relative shrub cover. Locally distributed at drier mid-elevation chaparral sites as at upper Jasper Trail, Chariot Canyon, and western McCain Valley Resource Conservation Area = **Chamise-Cupleaf ceanothus series 37105.00 (no associations defined)**

A4. Redshank (*Adenostoma sparsifolium*) dominant; 60% or more relative cover. The "pure" expression of redshank dominance is less extensive than the next series, but is most common in the same general vicinity - the northwestern corner of the park. A few stands occur in the far southern portion of the mapping area as west of Mt. Tule in the In-Ko-Pah Range **= Redshank Series 37501.00**

A5. Chamise and redshank co-dominant; both species at least 30% relative cover and both exceed any other species in cover. This is a common chaparral from the Western San Ysidro Mtns. north to Terwilliger Valley, it is rare elsewhere **= Redshank-Chamise Series 37503.00 (no associations defined)**

A6. Eastwood manzanita (*Arctostaphylos glandulosa*) dominant; 60% or more relative cover. A chaparral of the upper elevations rarely below 5000 ft., but common on open ridges and south slopes in Mt. Laguna, Combs Pk., and Los Coyotes area **= Eastwood manzanita series (37302.00)**

> **a.** Adams manzanita *(Arctostaphylos glandulosa* ssp. *adamsii*) dominant 60% or more relative cover. Typically low canopy (<1m) of windswept sites. Locally common in Mt. Laguna, Garnet Peak area **= Adams manzanita association 37302.02**
>
> **b.** Eastwood manzanita and birch-leaf mountain mahogany (*Cercocarpus betuloides*) in near equal abundance. Uncommon chaparral of upper elevations in vicinity of Combs Pk. and Lucky Five Ranch **= Eastwood manzanita-Mountain mahogany association 37302.03**

A7. Pink-bract manzanita (*Arctostaphylos pringlei*) dominant; 60% or more relative cover often with sparse emergent canopy of Coulter pine (less than 5% cover). Common only at highest elevations (>5200 ft.) vicinity of Combs Pk. Hot Springs Mtn. and locally at Monument Pk. = **Pink-Bracted Manzanita series 37308.00**

A8. Pink-bract manzanita, point-leafed manzanita (*Arctostaphylos pungens*) and shrub interior live oak (*Quercus wislizenii fructescens)*, form canopy with sparse emergent Coulter pine. Common only in bouldery high country south-southeast of Lost Valley >4500 ft. = **Mixed Point-leaf - Pink-bract Manzanita series 37309.00**

A9. Birch-leaf mountain mahogany (*Cercocarpus betuloides* or C. *minutifolius*) dominant. Widespread chaparral or dwarf woodland at moderate to high elevations, typically on n and e-facing slopes **= Birchleaf Mountain Mahogany series (76100.00)**

> **a.** Birch-leaf mountain mahogany dominant with scrub oak (*Quercus berberidifolia*) as major secondary species. Occasional at higher elevations as near Combs Pk, and Stephenson Pk. = **Mountain mahogany-scrub oak association 76100.03**
>
> **b.** *Cercocarpus* spp. and big-berry manzanita (*Arctostaphylos glauca*) co-dominant, both species at least 30% relative cover and both exceed any other species in cover. occasional on drier chaparral on escarpments above Mason

Valley and Culp Valley = **Mountain mahogany-bigberry manzanita association 76100.04**

A10. Muller's oak (*Quercus cornelius-mulleri*) dominant; 60% or more relative cover in tall shrub strata. A common, widespread dry chaparral adjacent to desert slopes through west side of park, denser stands with relatively low cover of drought-deciduous desert shrubs may be keyed here (see also desert transition scrub) **= Muller oak series (37415.00)**

a. Muller oak and sugarbush (*Rhus ovata*) codominant**= Muller oak-sugarbush association 37415.01**

b. Muller oak dominant with birch-leaf mountain mahogany second in importance; occasional in upper moister zone of Muller oak dominance as at Jasper Trail, Pinyon Ridge **= Muller oak-Mountain Mahogany association 37415.03**

A11. Mix of scrub oak (*Quercus berberdifolia), Cercocarpus* spp., *Adenostoma* spp., other shrubby *Quercus*, and cupleaf ceanothus *(Ceanothus greggii)*. No clear dominant but scrub oak always at least 2%. The common upper elevation mixed mesic chaparral of the Lost Valley - Combs Pk. area, also occurs near Garnet and Monument Pks. **= Mixed Scrub oak series 37406.00 (no associations defined)**

A12. Scrub oak *(Quercus berberdifolia*) dominant, 60% or more relative cover. Fairly common above 4000ft. on western edge of park from Mt. Laguna area to Combs Pk. area **= Scrub oak series 37407.00**

A13. Shrubby interior live oak (*Quercus wislizenii frutescens*) and/or Palmer oak (*Q. palmeri)* dominant, 60% or more relative cover. Occasional on west side of park from McCain - Thing Valley area to Combs Pk, usually above 4000 ft. in mesic settings. Note: difficulties in identification preclude differentiation between Palmer and Interior live oak stands. **= shrub Interior live oak series 37401.00**

A14. Cupleaf ceanothus (*Ceanothus greggii*) dominant. Occasional up and down the western margin of the park usually in dry chaparral near desert transition scrub **= Cupleaf ceanothus association (in Cupleaf-Fremontia-Oak series 37212.00) 37212.01**

A15. Vegetation is resprouting and seeding chaparral shrubs of undetermined type (<u>for air photo interpretation only</u>). Scattered throughout chaparral zone; a catch-all due to difficulty of interpreting early seral signature of some recently burned stands = **Recently burned chaparral 37999.00**

B. Vegetation dominated by winter deciduous species of high elevations:

B1. Stands dominated by deerbrush (*Ceanothus integerrimus*), may be mixed with other montane brush species such as serviceberry (*Amelanchier utahensis*). Rare only above 5200 ft on northerly exposures; small stands (<mmu at Combs Pk) a few mappable at Hot

Springs Mtn. = **Deerbrush series 37206.00**

B2. Stands dominated by skunkbrush (*Rhus trilobata*), usually as clonal thickets. Small (<mmu) stands exist at edges of swales and shallow valleys above 4000 ft in chaparral zone (as near Jasper Trail). Only mappable stands are in Los Coyotes in San Ignacio Canyon = **Skunkbrush Series 37802.00**

<u>Group IV:</u> Desert Transition Scrub: Mixed sclerophyll scrub and drought-deciduous sub-shrub scrub characterized by open large sclerophyll or otherwise evergreen scrub over shorter strata of high desert or south-coastal shrubs. In some cases large shrub strata is very open or non-existent.

A. vegetation dominated by large shrubs, usually at least twice as tall as under story of drought deciduous species

Not as above: B

A1. California juniper (*Juniperus californica)* as scattered canopy (usually 3-10%) over other lower shrubs. Note: on rare occasions juniper may be an overstory shrub over chaparral, usually dominated by chamise. Such stands exist at the head of Grapevine Canyon **= California Juniper Series 89100.00**

a. The most common association is California juniper with Agave and other shrubs such as *Viguiera parishii*, *Bernardia myrtifolia*, and *Ephedra nevadensis*. Common on slopes east of Earthquake and Blair Valleys **89100.03**

b. California juniper over an under story dominated by blackbush (*Coleogyne ramosissima*). Common on higher slopes on the east side of Earthquake Valley and in Pinyon Mountain area) = **California juniper-blackbush association 89100.04**

A2. Open-to moderately dense canopy of tall shrubs of catclaw (*Acacia greggii*) with scattered to dense low subshrubs= **Catclaw series (33040.00)**

a. Under story shrubs include; Cheesebush (*Hymenoclea salsola*) California buckwheat, deerweed, etc. Red brome (*Bromus madridtensis rubens*) common grass; often scattered sugarbush in canopy. Often occupies shallow valleys and flats in hills over 2800 ft, occasionally on slopes as at Culp Valley, Jacumba Valley, Upper Potrero, etc**. = Catclaw/California buckwheat association 33040.02**

A3. Vegetation with open over story of tall shrubs dominated by desert apricot (*Prunus fremontii*), often only 2-5% cover. Dominance may be shared with lotebush (*Ziziphus parryi*); under story dominated by low shrubs of desert sunflower (*Viguiera parishii*), deerweed, *Encelia actonii*, white sage *(Salvia apiana)*, California buckwheat. Usually between 2200-4000 ft. on rocky slopes. Fairly common throughout west side of park = **Desert Apricot series 33220.00**

A4. Sugarbush (*Rhus ovata*) as scattered canopy (as low as 3%) over other low desert transition shrubs; California buckwheat, matchweed (*Gutierrezia sarothrae*), Mojave yucca (*Yucca schidigera*), cholla (*Opuntia acanthocarpa* or *echinocarpa*). No other tall evergreen shrubs exceed sugarbush in cover, although others (California juniper, desert apricot, lotebush) may equal it in cover. If Muller oak equals cover of sugarbush go to Muller oak series. = **Sugarbush series 37801.00 (no associations defined)**

A5. Vegetation dominated by low desert scrub species (brittlebush, sweetbush, burrobush), but with the yucca-like *Nolina bigelovii* as a visual dominant (ca. 3-10% cover) evenly dispersed over the stands. Other emergent shrubs (catclaw, juniper, desert lavender) less cover than *Nolina*. Rare, only known from bouldery granitic slopes near Carrizo Palms and the Carrizo Railroad grade = ***Nolina* Series 33080.00 (no associations defined)**

A6. Muller oak (*Quercus cornelius-mulleri*) dominant; 60% or more relative cover in tall shrub strata. A common, widespread dry chaparral adjacent to desert slopes through west side of park, open stands with relatively high cover of drought-deciduous desert shrubs may be keyed here (see also chaparral) **= Muller oak series (37415.00)**

- **a.** Muller oak and sugarbush codominant, with open under story of California buckwheat, cholla (*Opuntia* spp.), white sage, etc. Bigberry manzanita a common associated overstory shrub **= Muller oak-sugarbush association 37415.01**
- **b.** Muller oak scattered canopy (3-12%) over low desert shrubs. No other evergreen shrub exceeds Muller oak in cover although others (sugarbush, birch-leaf mountain mahogany, cupleaf ceanothus, and California juniper) in total, may equal it in cover **= Muller oak series, Quco-Erfa-Erli association 37415.02**

B. Vegetation dominated by low semi-desert or coastal sage-type shrubs. Emergent larger shrubs not more than 5% total and no single emergent > 3%

B1. California buckwheat (*Eriogonum fasciculatum)* dominant or co-dominant, no emergent large shrubs total over 5%. There is much variation in this series and only one association came out in analysis (insufficient sampling to further define associations). Many stands of California buckwheat also have Wright's buckwheat associated with them (upper valleys in chaparral zone as near Jasper Trail, Culp Valley). This is often a seral disturbance community following fire or brush clearing (as W of Turkey Track). May range up to over 6000 ft. as on Mt Stephenson. Emergent associated shrubs may be desert types such as juniper and jojoba (*Simmondsia chinensis*), or in chaparral belt include such species as chamise, Muller oak, and various manzanitas **= California buckwheat series (32040.00)**

- **a.** California buckwheat and burrobush (*Ambrosia dumosa*) in near equal importance, often with desert sunflower (*Viguiera parishii*) as close co-dominant. Other shrubs include deerweed and Agave. Fairly common on upper desert slopes from 1500-2500 ft. as in Grapevine Canyon, Mason Valley = **California buckwheat-burrobush 32040.05**

B2. California buckwheat and white sage (*Salvia apiana)* co-dominant both at least 30% relative cover without substantial emergent layer of tall shrubs. Usually on relatively steep rocky slopes from 2500 to 5000 ft. Stands usually small, surrounded by chaparral **= California buckwheat-White Sage series 32100.00 (no associations defined)**

B3. Vegetation dominated by low soft-leaved shrubs of Wright's buckwheat (*Eriogonum wrightii* ssp. *membranaceum*); 60% or more relative cover. Typically interspersed with chaparral, montane woodlands, or desert transition scrub in areas above 3500 ft. Stands usually small, often associated with big sagebrush (*Artemisia tridentata*) and California buckwheat in shallow swales and flats with relatively deep granitic soils; e.g., Montezuma Valley, McCain Valley, Jasper Trail: **= Wright's buckwheat series 32041.00 (no associations defined)**

B4. Big Sagebrush (*Artemisia tridentata*) dominant, or as a shrub, co-dominant over the subshrub, Wright's buckwheat. Scattered small stands on deep well drained soils, usually surrounded by chaparral or montane woodlands above 3500 ft. as on Pinyon Ridge, Jasper Trail, Lost Valley, McCain Valley. = **Big Sagebrush series 35100.00 (no associations defined)**

B5. Cheesebush *(Hymenoclea salsola*) dominates shrub canopy = **Cheesebush Series (33200.00)**

> **a.** in dry swales and small valleys surrounded by desert transition scrub and chaparral (ca. 2800-4500 ft.), other common species include California buckwheat and deerweed (*Lotus scoparius)*, red brome (*Bromus madritensis rubens*) common non-native grass. Common in Culp Valley ranging south to In-Ko-Pah Mtns. = **Cheesebush-California buckwheat association 33200.02**

B6. Vegetation of disturbed areas (usually fire within the last 15-20 years) dominated by deerweed (*Lotus scoparius*). Deerweed usually most abundant small shrub (at least 5%). Scattered large shrub cover of catclaw, desert apricot (*Prunus fremontii*), lotebush (*Ziziphus parryi*), California juniper, Muller oak, or sugarbush is less than 5%. Scattered locations in desert transition zone; W side of Earthquake valley, upper Grapevine Canyon, etc. **= Deerweed series 32180.00 (no associations defined)**

B7. Round-leaved rabbitbrush (*Chrysothamnus teretifolius*) is the dominant or co-dominant with other desert transition shrubs such as California buckwheat, matchweed (*Gutierrezia sarothrae*), Mojave prickly pear (*Opuntia chlorotica*). Largely restricted to vicinity of Table Mountain and other parts of the Jacumba Mtns. Appears to often be seral following fire in what once was juniper series. = **Round-leaf Rabbitbrush Series 35330.00**

<u>Group V</u>: Desert Scrub Vegetation: vegetation dominated by desert shrubs and sub-shrubs, chaparral and montane evergreen sclerophylls and conifers if present, generally less than 1% cover. This includes scrub of washes and arroyos in the upper desert.

1. Creosote bush (*Larrea tridentata*) with Mojave yucca (*Yucca schidigera*) evenly distributed (creosote >2% cover, Yucca 1% or more). The common high desert vegetation with creosote bush **= Creosote bush-Mojave Yucca Series 33210.00**

> **a.** The two nominate species mixed with Nevada ephedra (*Ephedra nevadensis*) and other shrubs, with big galletta grass (*Pleuraphis rigida*) common in ground layer, lower fans and bajadas in Earthquake and Blair Valleys = **Creosote bush-yucca-Nevada ephedra/big galletta association 33210.01**
>
> **b.** The two nominate species mixed with burrobush (*Ambrosia dumosa*). This is the lowest elation expression of the series as around Plum Canyon and lower Grapevine Canyon **= Creosote bush-Mojave yucca-burrobush 33210.02**
>
> **c.** Creosote bush is dominant tall shrub with an even scattering of Mojave yucca, but greater cover often by Agave. Occurs on upper bajadas in Blair and Earthquake Valleys **= Creosote-Mojave yucca-Agave association 33210.03**

2. Mojave yucca dominant tall shrub emergent over other low desert shrubs and grasses, no other tall shrub equals or exceeds Yusc in cover. Big galleta grass may comprise more cover, but yucca is shrublayer dominant. Scattered in Blair and Earthquake valleys as near Blair Valley Ranger station and below Foot and Walker Pass**= Mojave Yucca series 33070.00 (no associations defined)**

3. Creosote bush dominant tall shrub, although other subshrubs may equal or exceed it in cover **= Creosote bush series 33010.00**

> **a.** Creosote bush with low shrubs such as white rattany (*Krameria grayi*) and big galleta grass common. Gently sloping bajadas in Blair and Earthquake valleys. = **Creosote bush-white rattany-big galleta association 33010.07**
>
> **b.** Creosote bush dominant tall shrub over brittlebush, desert sunflower, Agave. This is very similar to the Creosote-brittlebush stands of the lower desert with the addition of some upper desert species such as *Viguiera parishii*. Insufficient sample size to further differentiate from low elevation stands. Uncommon on S-facing slopes in Earthquake valley area. **Creosote bush-brittlebush association 33010.04**

4. Blackbush (*Colyogyne ramossisima*) strongly dominates shrub layer with no large shrubs equaling or exceeding *Coleogyne* in cover. Locally common on Pinyon Mountain and on bajadas and slopes above Earthquake Valley. Possibly rare elsewhere (In-Ko-Pah Mtns.) **= Blackbush series (33020.00)**

> **a.** all stands within the park are probably within the description of Spolsky **= Sonoran blackbush association 33020.01**

5. Stands dominated by brittlebush (*Encelia farinosa*), other tall shrubs less than 5% cover and no single tall shrub > 5%. **= Brittlebush series (33030.00)**

> **a.** brittlebush dominant shrub with lower proportions of California buckwheat, desert sunflower (*Viguiera parishii*) and *Agave deserti*. This is the upper

elevation form of the series on s-facing slopes as on Earthquake Valley, Mason Valley, Grainite Mtn, etc. **= Brittlebush- California buckwheat-Agave association 33030.03**

6. Desert sunflower (*Viguiera parishii*) is greatest cover or equal cover of any other single shrub with total cover of emergent tall shrubs not exceeding 5% **= Desert Sunflower series 33032.00**

a. Desert sunflower and Agave co-dominant. mostly n and e-facing slopes between 200-3000 ft elevation in many parts of the park (Hellhole, Borrego Palm, Carrizo Canyons = **Desert sunflower-Agave association 33032.01**

b. Desert sunflower and California buckwheat both important (both 2% or greater, none exceeding the other by more than a few percent. some lower elevation stands approach California buckwheat-burrobush (32040.05) association, but burrobush is rare or absent **= Desert sunflower-California buckwheat association 33032.02**

7. Cheesebush (*Hymenoclea salsola)* dominant usually in washes or other disturbed areas in this upper desert area **= Cheesebush series (33200.00)**

a. washes and disturbed areas on bajadas below about 2000 ft. Widespread. = **Cheesebush wash association 33200.01**

8. Scalebroom (*Lepidospartum squamatum*) dominant. Restricted to active washes in upper Coyote Canyon (only mappable stands) small stands also occur in upper San Felipe Cr. **= Scalebroom series 32070.00 (no associations defined)**

9. Deerweed, (*Lotus scoparius*) clearly dominant with no significant cover of emergent shrubs. Usually seral to other upper desert scrub types, in areas with recent fire (The Potrero, Butterfield Stage, etc.) **= Deerweed series 32180.00 (no associations defined)**

10. Allscale (*Atriplex polycarpa*) clearly dominant. Occasional in upper desert as in Mason Valley and Grapevine Canyon**= Allscale series 36340.00 (no associations defined)**

11. Four-wing saltbush (*Atriplex canescens*) clearly dominant. Occasional small stands as adjacent to playas in Earthquake and Little Blair Valleys, most stands at upper elevations are below minimum mapping unit. = **Fourwing saltbush series 36310.00 (no associations defined)**

12. Desert Agave **(***Agave deserti*) 5% or more cover with no spp. exceeding it in cover = **Desert Agave series (33075.00)**

a. Agave dominant with Mojave yucca evenly distributed in light cover. Little Blair, Blair, and Earthquake valleys = **Desert Agave-Mojave Yucca association 33075.02**

<u>Group VI</u>: Grassland: grasses surpass any other lifeform in cover; no significant layers of

trees or shrubs.

1. Red Brome (*Bromus madritensis rubens*) an invasive non-native species, dominant with no shrub or subshrub cover totaling > 5%. Generally small stands where some grazing or other disturbance has taken place. (as at Culp Valley) **= Red Brome Series 42025.00**

2. The non-native annual grass *Schismus barbatus* dominant; with no shrub or subshrub cover totaling > 5%. = ***Schismus* series (42090.00)**

a. occurs on silty and clay flats and playas of relatively low alkalinity particularly Blair and Earthquake valley playas, often with the non native grass *Bromus madritensis rubens* and native herb *Hoffmannseggia glauca* present, very low shrub cover includes scattered mesquite and four-wing saltbush (*Atriplex canescens),* = ***Schismus* playa association 42090.01**

3. Cheatgrass (*Bromus tectorum)* dominant with no shrub or subshrub cover totaling > 5% (Oriflamme Mtn.) = **Cheatgrass series (42020.00)**

a. Cheatgrass dominant but with significant cover of the annual ripgut brome (*B. diandrus*) altered pasture areas on Oriflamme Mtn. = **Cheatgrass-ripgut association 42020.02**

4. Non-native perennials such as intermediate wheat grass dominant with no shrub or subshrub cover totaling > 5% (Oriflamme Mtn.)= **introduced perennial grassland 42050.00**

5. The perennial native, big galleta grass (*Pleuraphis rigida*), strongly dominant (10-35% cover), usually with scattered Mojave yucca and catclaw as emergents (<5% cover) **= Big Galleta Series 41030.00**

<u>Group VII</u>: Unvegetated areas with perennial plant cover <2%

1. Rock outcrops and cliff faces = **upper elevation rock outcrop 99900.05**

2. Polygon is an active wash **= sandy to cobbly wash bottom 99900.01**

3. Polygon is a parking lot, building or other human clearing (may have some vegetation, but slight or non-native) = **development 99900.06**

4. Polygon is open water (one small reservoir in Lost Valley) **= open water 99900.08**

Please see Table 1 for a summary of the classification.

Summary of Ecological Relationships between all Mapping Units Portrayed in the Key (Table 1)

Table 1

SUMMARY OF ECOLOGICAL RELATIONSHIPS BETWEEN ALL MAPPING UNITS PORTRAYED IN THE KEY

DIVISION	GROUP	SUB-GROUP	SERIES OR UNVEGETATED MAPPING UNIT	ASSOCIATION
Division A. Vegetation below the zone of Sugarbush, Mojave yucca , and California juniper.	GROUP I : Low elevation desert washes, arroyos, and terraces immediately above washes, not including more permanent intermittent streams or springs with riparian vegetation dominated by willow, cottonwood, Fan palm, or Sycamore.	A. Trees or large shrubs of Mesquite, Ironwood, Blue Paloverde, smoketree, desert willow,or Tamarisk present.	1. Mesquite series (61510.00)	a. Mesquite wash association (61510.02)
			2. Ironwood series (61560.00)	
			3. Blue Paloverde series (61540.00)	
			4. Smoketree series (61570.00)	
			5. Desert willow series (61550.00)	
			6. Catclaw series (33040.00)	a. Catclaw wash association (33040.01)
			7. Tamarisk series (63810.00)	a. Shrub tamarisk association (63810.02)
			8. Ironwood-Smoketree-blue Paloverde series (61530.00)	
		B. Dominant layer is composed of shrubs.	1. Desert Lavender series (33190.00)	
			2. Cheesebush series (33200.00)	
			3. Allscale series (36340.00)	
			4. *Baccharis emoryi* series (63520.00)	
			5. Burrobush series (33060.00)	
			6. Agave series (33075.00)	
			7. Creosote bush series (33010.00)	
			8. Creosote bush–burrobush series (33140.00)	
		C. No significant cover of any woody perennial species.	1. Sandy–cobbly wash bottom (99900.01)	
			2. Saltgrass series (41200.00)	
	GROUP II: Alkali and Saline Areas around Playas and Depressions.	A. Shrub-dominated vegetation.	1. Bush seepweed series (36220.00)	
			2. Iodine bush series (36120.00)	
			3. Mesquite series (61510.00)	a. Mesquite alkaline association (61510.03)
			4. Allscale series (36340.00)	
			5. Fourwing Saltbush series (36310.00)	
			6. Mixed saltbush series (36360.00)	
			7.Creosote bush series (33010.00)	a. Allscale association (33010.05)
		B. Shrubs not dominant.	1. *Schismus* series (42090.00)	a. *Schismus* playa association (42090.01)
			2. Alkaline Playa (99900.07)	
	GROUP III: Low elevation springs and permanent wetlands generally below 2500 ft. elevation.	A. Shrub or tree-dominated vegetation.	1. Tamarisk series (63810.00)	a. *Tamarix aphylla* type (63810.01)
				b. Shrub tamarisk type (63810.02)
			2. Desert Fan Palm series (61520.00)	a. Desert fan palm spring type (61520.02)
			3. Mesquite series (61510.00)	a. Mesquite alkaline spring type 61510.06
		B. Shrubs not dominant.	1. Bulrush series (52101.00)	a. California bulrush association (52101.01)
				b. Threesquare association (52101.02)
			2. Cattail series (52103.00)	
	GROUP IV: Low Elevation Uplands.	A. Stands dominated by shrubs.	1. Creosote bush–burrobush series (33140.00)	a. Creosote bush-burrobush–indigo bush association (33140.06)
				b. Creosote bush-burrobush–sandy association (33140.07)
				c. Creosote bush-burrobush–desert holly association (33140.08)
				d. Creosote bush-burrobush–bedstraw–*Lyrocarpa* association (33140.09)
			2. Creosote bush series (33010.00)	a. Creosote bush – Brittlebush association (33010.04)
			3. Burrobush series (33060.00)	a. Burrobush - goldenhead association (33060.01)

DIVISION	GROUP	SUB-GROUP	SERIES OR UNVEGETATED UNIT	ASSOCIATION
			4. Brittlebush series (33030.00)	a. Brittlebush succulent association (33030.01)
				b. Brittlebush - desert fir association (33030.02)
			5. Ocotillo series (33090.00)	
			6. Teddybear Cholla series (33050.00)	
			7. Fagonia series (33061.00)	
			8. Elephant tree unique stands (33120.00)	
			9. *Caesalpinia virgata* unique stands 33062.00)	
			10. Agave series (33075.00)	
		B. Stands not dominated by woody species, perennial vegetation less than 3% cover total.	1. Gypsum deposits (99900.02)	
			2. Mud hills (99900.03)	
			3. Low elevation rock outcrop (99900.04)	
			4. Active dunes and sand fields (22010.00)	
			5. Development (99900.06)	
		C. Stands dominated by trees.	1. Ironwood series (61560.00)	
Division B. Vegetation of the upper elevations including and above the zones of species such as Sugarbush, Mojave yucca), and California juniper.	Group I: Upper Elevation Riparian, Springs, Meadows, and Seeps. Vegetation dominated by trees and large shrubs.	A. Stands dominated by trees and large shrubs.	1. Arroyo willow series (61201.00)	
			2. Narrow-leaf willow series (63110.00)	
			3. Mesquite series (61510.00)	a. Mesquite-willow association (61510.07)
				b. Upper desert mesquite spring association (61510.08)
			4. Mulefat Series (63500.00)	
			5. Broom Baccharis series (63530.00)	
			6. Arrowweed series (63710.00)	
			7. Fremont Cottonwood series (61130.00)	a. Fremont Cottonwood–mesquite association (61130.06)
			8. Fan Palm series (61520.00)	a. Fan Palm-Sycamore association (61520.03)
			9. Desert Willow series (61550.00)	
			10. Sycamore series (61310.00)	
			11. White alder series (61420.00)	
			12. Catclaw series (33040.00)	a. Catclaw wash association (33040.01)
			13. Quailbush series (36370.00)	
		B. Stands dominated by herbaceous species.	1. Mexican rush series (45500.00)	
			2. Montane Meadow (45310.00)	
	Group II: Upper Elevation Montane Forests and Woodlands.	A. Vegetation of Montane or Coastal Affinities.	1. Coast Live Oak series (71060.00)	a. Coast live oak/Wright's buckwheat association (71060.21)
				b. Coast Live oak – Coulter Pine association (71060.22)
			2. Canyon live oak series (71050.00)	
			3. California Bay series (74100.00)	
			4. Jeffrey Pine series (87020.00)	a. Jeffrey Pine-California black oak association (87020.24)
			5. California black oak series (71010.00)	
			6. Coulter Pine series (87090.00)	
			7. Coulter Pine- canyon live oak series (87210.00)	

DIVISION	GROUP	SUB-GROUP	SERIES OR UNVEGETATED UNIT	ASSOCIATION
			8. Parry (or Four-needle) Pinyon Pine series (87030.00)	
		B. Vegetation of Desert Affinities.	1. Single-leaf pinyon pine series (87040.00)	
			2. Curl-leaf Mountain Mahogany series (76200.00)	
	Group III: Upper Elevation Dense Chaparral.	A. Vegetation dominated by evergreen broad or needle-leaf chaparral species.	1. Chamise series (37100.00)	
			2. Chamise-Eastwood Manzanita series (37106.00)	
			3. Chamise-Cupleaf ceanothus series (37105.00)	
			4. Redshank series (37501.00)	
			5. Redshank-Chamise series (37503.00)	
			6. Eastwood manzanita series (37302.00)	a. Adams manzanita association (37302.02)
				b. Eastwood manzanita-Mountain mahogany association (37302.03)
			7. Pink-Bracted Manzanita series (37308.00)	
			8. Mixed Point-leaf – Pink-bract Manzanita series (37309.00)	
			9. Birchleaf Mountain Mahogany series (76100.00)	a. Mountain mahogany-scrub oak association (76100.03)
				b. Mountain mahogany-bigberry manzanita association (76100.04)
			10. Muller oak series (37415.00)	a. Muller oak-sugarbush association (37415.01)
				b. Muller oak-Mountain Mahogany association (37415.03)
			11. Mixed Scrub oak series (37406.00)	
			12. Scrub oak series (37407.00)	
			13. Shrub Interior live oak series (37401.00)	
			14. Cupleaf-Fremontia-Oak series (37212.00)	a. Cupleaf ceanothus association (37212.01)
			15. Recently burned chaparral (37999.00)	
		B. Vegetation dominated by winter deciduous species of high elevations.	1 Deerbrush series 37206.00	
			2. Skunkbrush series (37802.00)	
	Group IV: Desert Transition Scrub: Mixed sclerophyll scrub and drought-deciduous sub-shrub scrub.	A. Vegetation dominated by large shrubs, usually at least twice as tall as understory of drought deciduous species.	1. California Juniper series (89100.00)	a. California juniper-Agave association (89100.03)
				b. California juniper-blackbush association (89100.04)
			2. Catclaw series (33040.00)	a. Catclaw/California buckwheat association (33040.02)
			3. Desert Apricot series (33220.00)	
			4. Sugarbush series (37801.00)	
			5. *Nolina* Series (33080.00)	
			6. Muller oak series (37415.00)	a. Muller oak-sugarbush association (37415.01)
				b. Muller oak-California buckwheat-Narrowleaf goldenbush association (37415.02)
		B. Vegetation dominated by low semi-desert or coastal sage-type shrubs.	1. California buckwheat series (32040.00)	a. California buckwheat-burrobush association (32040.05)
			2. California buckwheat-White Sage series (32100.00)	

DIVISION	GROUP	SUB-GROUP	SERIES OR UNVEGETATED UNIT	ASSOCIATION
			3. Wright's buckwheat series (32041.00)	
			4. Big Sagebrush series (35100.00)	
			5. Cheesebush series	a. Cheesebush-California buckwheat association (33200.02)
			6. Deerweed series (32180.00)	
			7. Round-leaf Rabbitbrush series (35330.00)	
	Group V: Desert Scrub Vegetation: vegetation dominated by desert shrubs and sub-shrubs, chaparral and montane evergreen sclerophylls and conifers if present, generally of low cover.	No sub-groups defined; see series.	1. Creosote bush-Mojave Yucca series (33210.00)	a. Creosote bush-yucca-Nevada ephedra/big galletta association (33210.01)
				b. Creosote bush-Mojave yucca-burrobush (33210.02)
				c. Creosote-Mojave yucca-Agave association (33210.03)
			2. Mojave Yucca series (33070.00)	
			3. Creosote bush series (33010.00)	a. Creosote bush-white rattany-big galleta association (33010.07)
				b. Creosote bush-brittlebush association (33010.04)
			4. Blackbush series (33020.00)	a. Within the description of Spolsky = Sonoran blackbush association (33020.01)
			5. Brittlebush series (33030.00)	a. Brittlebush- California buckwheat-Agave association (33030.03)
			6. Desert Sunflower series (33032.00)	a. Desert sunflower Agave association (33032.01)
				b. Desert sunflower-California buckwheat association (33032.02)
			7. Cheesebush series (33200.00)	a. Cheesebush wash association (33200.01)
			8. Scalebroom series (32070.00)	
			9. Deerweed series (32180.00)	
			10. Allscale series (36340.00)	
			11. Fourwing saltbush series (36310.00)	
			12. Agave series (33750.00)	a. Desert Agave-Mojave Yucca (association 33075.02)
	Group VI: Grassland: grasses surpass any other lifeform in cover; no significant layers of trees or shrubs.	No sub-groups defined, see series.	1. Red Brome series (42025.00)	
			2. *Schismus* series (42090.00)	a. *Schismus* playa association (42090.01)
			3. Cheatgrass series (42020.00)	a. Cheatgrass-ripgut association (42020.02)
			4. Introduced perennial grassland (42050.00)	
			5. Big Galleta series (41030.00)	
	Group VII: Unvegetated areas with perennial plant cover <2%.	No sub-groups defined, see unvegetated mapping units.	1. Sandy to cobbly wash bottom (99900.01)	
			2. Upper elevation rock outcrop (99900.05)	
			3. Development (99900.06)	
			4. Open Water (99900.08)	

Cross-walking to Other Classifications:

The term "cross-walking" is commonly used in vegetation mapping and classification. It refers to the development of relationships between classification systems. The need for cross-walking arises when, as in this project, there is more than one classification system in use for a given area. In this project the contract calls for relating the principle MCV classification (Sawyer and Keeler-Wolf 1995) to the Wildlife Habitat Relationships (Mayer and Laudenslayer 1988), Holland (1986 and as modified by San Diego County 1996), and Spolsky (1979) classifications.

In a vegetation map cross-walking is never precise. Assuming classifications arise independently, the meaning of one classification unit may not always encompass, or be nested within, the other classification unit(s) to which it's being related. Choices always have to be made about those classification unit(s) that are partially included within two or more types of another classification system. For labeling a vegetation map one and only one choice has to be made for each relationship drawn. Thus, typically a "modal" expression of the vegetation unit in question is chosen. For example, the MCV unit Creosote bush-burrobush (*Larrea tridentata-Ambrosia dumosa*) series actually includes parts of Holland's (1986) Sonoran creosote bush scrub as well as Mojavean creosote bush scrub. However, as most of the Anza-Borrego expression of Creosote bush-burrobush series is encompassed by Holland's Sonoran Creosote bush scrub, we chose it as the single type to be related to the MCV Creosote bush-burrobush series.

The complexity and uncertainty of such relationships arise not only from independent evolution of classifications, but also from their imprecise definitions, without quantitative rules for proper interpretation. The best crosswalks are those which have been developed with a good understanding of the meaning and definitions of each classification system. In this vein, we submitted our preliminary cross-walk for review by San Diego County (SANDAG) and the DPR Southern Service Center and Anza Borrego State park Staff. The final cross-walk is presented in Table 2 (see attachment).

In this table the primary MCV classification units - the series or other unvegetation classification units - are bolded with underlying associations, if defined, not bolded. The code numbers are in the same box.

Acreage Information:

Information about the number of acres of each vegetation type within the Anza Borrego Desert State Park and environs vegetation mapping area is provided in Table 3.

Table 3

VEGETATION ACREAGE SUMMARY FOR ANZA-BORREGO DESERT STATE PARK AND ENVIRONS

VEGETATION SERIES CODE	VEGETATION SERIES NAME	NUMBER OF POLYGONS	ACRES
3314000	Creosote Bush-Burrobush	2231	133995.9
3303000	Brittlebush	1288	113642.9
3301000	Creosote Bush	1639	94849.4
3306000	Burrobush	1576	79246.2
9990003	Mud Hills	652	75555.5
8910000	California Juniper	935	56868.7
3741500	Muller Oak	1157	36515.2
OUT	Private Inholding	1	34406.2
3303200	Desert Sunflower	605	25980.1
3710000	Chamise	976	21127.3
3750300	Redshank-Chamise	353	20980.9
3780100	Sugarbush (Rhus ovata)	606	18290.6
3204000	California Buckwheat	607	16722.3
3321000	Creosote Bush-Mojave Yucca	291	15177.1
8704000	Single-leaf Pinyon Pine	227	12574.4
3322000	Desert Apricot	327	11829.3
6151000	Mesquite	801	9939.6
7610000	Birchleaf Mountain Mahogany	270	8859.3
3305000	Teddybear Cholla	101	8793.4
3740600	Mixed Scrub Oak	278	8044.3
3307500	Desert Agave	198	7576.3

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VEGETATION SERIES CODE	VEGETATION SERIES NAME	NUMBER OF POLYGONS	ACRES
3304000	Catclaw Acacia	360	7128.7
6157000	Smoketree	195	6642.5
3309000	Ocotillo	98	6393.8
9990006	Development	217	5893.2
3320000	Cheesebush	401	5612.2
3750100	Redshank	168	5535.0
3710600	Chamise-Eastwood Manzanita	162	5346.2
6154000	Blue Paloverde	89	5204.1
3730200	Eastwood Manzanita	155	4653.0
3319000	Desert Lavender	426	4582.5
3218000	Deerweed (Lotus scoparius)	103	3976.6
3799900	Recently Burned Chaparral	31	3865.7
6156000	Ironwood	73	3734.7
3730800	Pink-bracted Manzanita	101	3497.2
3636000	Mixed Saltbush	39	2726.9
3710500	Chamise-Cupleaf Ceanothus	137	2479.9
3307000	Mojave Yucca	49	2317.4
8721000	Coulter Pine-Canyon Live Oak	45	2312.9
3730900	Mixed Point-leaf--Pink-bracted	49	2293.9
7106000	Coast Live Oak	161	2266.3
3306100	Fagonia	72	2022.0
3634000	Allscale	98	1965.0
7105000	Canyon Live Oak	111	1867.2
3302000	Blackbush	99	1758.8

VEGETATION SERIES CODE	VEGETATION SERIES NAME	NUMBER OF POLYGONS	ACRES
9990007	Playa	5	1749.6
3740100	Interior Live Oak Chaparral	95	1644.1
3210000	California Buckwheat-White Sa	193	1540.3
6155000	Desert Willow	96	1390.5
8709000	Coulter Pine	79	1381.2
3533000	Rabbitbush (Chrysothamnus ter	13	1199.6
8702000	Jeffrey Pine	30	1187.4
9990001	Sandy-Cobbly Wash	92	1147.1
9990004	Low Elevation Rock Outcrop	61	1131.0
9990005	Upper Elevation Rock Outcrop	50	1038.4
7101000	California Black Oak	83	949.1
3204100	Wright's Buckwheat	63	775.1
9990002	Gypsum	28	719.5
6381000	Tamarisk	36	696.8
4209000	Schismus	35	689.7
3510000	Big Sagebrush	78	589.5
3622000	Bush Seepweed	27	552.9
4202500	Red Brome	26	435.4
4205000	Introduced Perennial Grassland	20	374.2
3612000	Iodine Bush	11	354.1
4531000	Montane Meadow	9	317.4
4103000	Big Galleta	17	303.0
6120100	Arroyo Willow	60	281.1
6113000	Fremont Cottonwood	26	232.1

VEGETATION SERIES CODE	VEGETATION SERIES NAME	NUMBER OF POLYGONS	ACRES
3308000	Nolina	16	215.8
3740700	Scrub Oak	35	183.9
6131000	Sycamore	20	182.1
3721200	Cupleaf Ceanothus-Fremontia-	13	169.4
3312000	Elephant Tree Unique Stands	5	166.2
8703000	Parry Pinyon Pine	3	146.3
4202000	Cheatgrass	9	140.0
6153000	Ironwood-Smoketree-Blue Palo	1	137.4
7410000	California Bay	25	126.8
6311000	Narrowleaf Willow	30	91.1
6142000	White Alder	5	80.8
3207000	Scalebroom	11	80.0
2201000	Active Dunes and Sandfields	3	78.2
6351000	Mulefat	14	75.6
6152000	Fan Palm	29	55.9
4550000	Mexican Rush	6	53.4
6352000	Baccharis emoryi	7	53.1
3306200	Caesalpinia virgata Unique Stan	5	52.2
3720600	Deerbrush Chaparral	7	50.2
5210100	Bulrush	1	47.7
3637000	Quailbush	2	44.6
6371000	Arrowweed	3	43.6
3780200	Skunkbush (Rhus trilobata)	5	35.1
7620000	Curlleaf Mountain Mahogany	4	21.8

VEGETATION SERIES CODE	VEGETATION SERIES NAME	NUMBER OF POLYGONS	ACRES
6353000	Broom Baccharis	6	16.9
4120000	Saltgrass	3	7.6
9990008	Open Water	1	4.8
		TOTAL ACREAGE OF VEGETATION	**928090.2**

Map Accuracy Assessment:

Introduction

Reporting the accuracy of a vegetation map is critical in the understanding of its usefulness and limitations. Formal accuracy assessments however, are often not undertaken because they are extremely labor-intensive and expensive. In this mapping effort we were constrained by the above limitations, but felt it necessary to attempt a partial accuracy assessment and to develop a methodology for others to continue these efforts beyond the scope of this project. We present here the methods and results of a partial accuracy assessment conducted in June 1997, and suggestions for further accuracy assessment.

General Methodology

Formal accuracy assessment entails two perspectives: 1) Accuracy from the standpoint of the producer, where one determines what percentage of a certain type of mapped vegetation is actually that type (this view assesses errors of omission), and 2) user's accuracy (this view assesses errors of commission). From a resource manager's standpoint the latter measurement is far more important because it gets at the reliability of the map. In other words, how likely is it that a particular mapping unit labeled as vegetation type "x" will actually be type "x" when it is visited on the ground?

The simplest way of depicting the summary statistics of an accuracy assessment is via a contingency table where the number of accurately determined vegetation types, based on field checking, is compared with the number of vegetation types labeled from the remote sensing effort (Story and Congalton 1986, Congalton 1991). For simple vegetation maps with just a few categories this process is very straightforward. However, in detailed complex vegetation maps with many categories, some being rare and some being abundant it is often not statistically relevant to report accuracy of all mapping units. Unless a significant sample of all vegetation types mapped is assessed, then a complete contingency table cannot be produced.

This problem arises from basic statistical considerations of the analysis. When we go out to collect field data to test the accuracy of a map, we must already assume something about the variability in our ability to accurately represent the different types of vegetation. These assumptions are important because they can lead to the most appropriate degree of effort in field checking (avoiding too many or too few samples). Thus, an easily distinguishable (distinctive signature from an aerial photo) vegetation type would be given a higher likelihood of being correctly identified than an amorphous, poorly distinguishable type. The number of samples we take should be based on the certainty of distinguishability.

Most accuracy assessment sample allocation is based on the binomial distribution (Congalton 1991). If we are to do a thorough accuracy assessment and to meet assumptions of the binomial distribution, it is necessary to have an adequate sample size of every mapping unit. At Anza Borrego this is not possible. There are numerous vegetation types that are rare, with fewer than 10 mapped stands in our GIS database. Many of these are difficult to distinguish from certain similar vegetation types, thus our level of confidence around them is not particularly high. The only way to have confidence that these types are mapped correctly is to visit each of them. On the other hand, there are numerous vegetation mapping types that are represented by hundreds of individual polygons and based on our assessment of their reliability we can devise field sampling regimes to collect a statistically valid sample size from these types and check their accuracy. Following the reporting of our partial accuracy assessment we present a table (Table 4) of all vegetation series mapped and suggestions about sample size for each of them.

Methods for the Partial Accuracy Assessment

Immediately following the completion of the identification keys derived from the analysis of the vegetation samples (see vegetation description section), we traveled to the park to conduct the accuracy assessment. We realized that there would not be enough time or money to spend more than a week of field time and were thus constrained by the amount of area we could cover and the number of samples we could collect. Fortunately, accuracy assessment sampling is not as labor-intensive as complete vegetation sampling. A simple field form was developed (see Figure 3 for a filled-out example, a blank sheet along with instructions for filling out is attached in Appendix 2) and field crews were trained in its proper use prior to the data collection. We emphasized rapid assessment and expected field crews to spend no more than 10 minutes describing an individual polygon.

A general assessment of which vegetation types would be amenable to assessment was made prior to the visit. We knew that at our most efficient, we couldn't expect to collect more than 10 samples per day per team. We would have three teams working for five days, therefore no more than 150 samples would be expected. From this total we determined which vegetation types could be easily sampled based on their expected sample size needed using the normal approximation of the binomial distribution (Cochran 1997). This means that we selected vegetation types that were accessible, distinguishable on aerial photos, and common enough to provide the number of samples needed to satisfy the statistical requirements in one small portion of the park.

In brief, the two primary considerations for selecting sample size are 1) the "p" level, a guess of how accurately we labeled a particular vegetation type in the mapping effort and 2) the "d," or margin of error in the estimate of how well we guessed the accuracy of a given vegetation type to be between the actual accuracy of the vegetation type (known as upper case “P”) and the estimated accuracy (lower case “p” as described above). In general, as your certainty in the “p” value increases, the number of samples required for accuracy assessment goes down. As the allowable discrepancy (“d”) between the actual accuracy (“P”) of a mapping type and its predicted accuracy (“p”) increases (e.g., you are more lenient about the margin of error) the fewer the samples required. These concepts are further discussed in texts such as Cochran (1977).

S14

Figure 3

Anza Borrego Desert State Park Vegetation Map
Accuracy Assessment Form for Series Determinations

SC.
JB.

Polygon Number: 1026

Date: 6/26/97

Field Assessed Vegetation Type:

Name	Code	Cover Value(LMH)
Brittlebush	33.030.00	M

List Top 6 Species in Polygon with Approximate Cover Values (%):

Enfa	15%	Latr	1%
Amdu	8%	Fosp	<1%
Opec	3%		

Problems with Interpretation:

No Cannot key out. Elaborate: ______

No Polygon is more than one type (type with greatest cover in poly should be entered above).

Types: ______ ______ ______

____ Other: ______

Do you think the vegetation has changed since Fall 1992? Y ____ N X If so how? What has changed?

For office use only

Photo Interpreted Type:

Name	Code	Cover Value(LMH)

Accuracy:

____ Correct ____ Incorrect

Completed Accuracy Assessment Form

To most efficiently sample the largest number of polygons, several analyses were done prior to the field work. The first was to randomly select four individual portions of the park. These were selected by using the air photo grid of 95 photos used to develop the map. Each photo had been given a row and column identifier code (see Figure 2). Those photos which did not have adequate access via paved or unsurfaced road were eliminated, leaving 21 photos available. We decided that we would select two high elevation and two low elevation photos for sampling. The 21 photos were divided into two groups based on the major division in the vegetation key that separated low elevation desert vegetation from all other high elevation vegetation. Following a simple random selection, four photos were chosen. Their locations are depicted on Figure **2**.

A GIS analysis using the roads and trails coverage for Anza-Borrego was then conducted. It was assumed that no polygon farther than 1 km from a travelable road would be selected, because of time constraints. It was also assumed that the map accuracy of polygons within 1 km of the road did not vary significantly from the accuracy of any polygons further than 1 km from roads. The GIS generated a list of all polygons within 1 km of roads on the four photos. For each of the four photos a group of 1 to 3 vegetation types were selected for accuracy assessment based on a high enough frequency in each photo to satisfy the minimum number for sampling, based on our judgment of their reliability of photo interpretation. The 1-3 types selected were sorted by type in the polygon database for each photo and the appropriate number of polygons was randomly selected from each group for sampling. These selected polygons were then highlighted on field copies of the polygon coverage overlain on copies of aerial photos for access. Field crews were then briefed on which groups of polygons would be their responsibility to sample and, of course, were never told what their determination was in the polygon attribute database.

In addition to the 1-3 primary types selected for each photo we also wanted to use this field period to randomly check a few other vegetation types. Although these other types may not have been as common and as accessible to provide statistically adequate samples, we felt that further validation and subsequent "fine tuning" of our notions of attributing certain types of vegetation polygons would be useful. As a rule all errors discerned in this partial accuracy assessment were subsequently corrected so that the current map has been improved from the edition used for the accuracy assessment.

The assessment was based on the determination of vegetation series. Although, in some cases, vegetation associations had been defined, we have been asked to base the map on the series. The unevenness of the determination of vegetation association based on field sampling and on photo interpretation also suggested to us that series was the proper assessment level.

Results

The results of the assessment are presented in Table 4. It should be noted that this is not a contingency table and that presentation of the full array of omission and commission errors is not possible because all possible vegetation types per photo were not sampled. This table reports the type of vegetation mapped and the type actually found to occur for each of the four photo areas assessed.
Due to time constraints and unforeseen logistical difficulties, the originally predicted number of accuracy samples taken was lower for some of the vegetation types than was required for the sample size calculations. Thus, in all, only five different vegetation types had a sufficiently large sample to be valid. These included California juniper series on photo 9p, Burrobush series and

Brittlebush series on photo 14s, Creosote bush-burrobush series on photo 7r, and Muller oak series on photo 6o.

Of the 169 total samples, 91 were devoted to the 5 vegetation types with sufficient samples. The following other types were targeted but did not receive adequate sample sizes: creosote bush series (photo 7R), Desert sunflower (photo 9p).

Table 4: Summary of accuracy assessment of five types taken in June 1997

Series (with code number)	**Sample size needed**	**Sample size taken**	**% correct**	**Incorrect determinations**
California juniper (8910000)	p=0.80, d=0.24 n=11	n=11	100%	0
Muller oak (3741500)	p=.08, d=0.20, n=16	n=16	87.5%	2 (one as chamise and 1 as desert apricot series)
Creosote bush-burrobush (3314000)	p=0.75, d=0.15, n=33	n=37	78%	8 (3 as creosote, 3 as ocotillo, 1 as brittlebush, 1 as smoketree series)
burrobush (3306000)	p=0.80, d=0.24, n=11	n=11	82%	2 (both as Creosote bush=burrobush series)
brittlebush series (3303000)	p=0.80, d=0.20, n=16	n=16	87.5%	2 (1 as burrobush, 1 as Creosote bush-burrobush series)

<u>Discussion</u>

The five selected types with adequate sample size ranged between 78 and 100% accuracy (mean = 85% accuracy). In general we were close to predicting the true accuracy of the sampled types and estimated the discrepancy conservatively enough. As was mentioned earlier, these five tested types were selected for their ease of access and interpretableness. Therefore, the average of 85% accuracy is probably higher than the overall accuracy of all mapped types in the project. To get some indication of the range of predictability of all mapped series not discussed above refer to Table 5. This table provides estimated p and d values with sample sizes and can serve as a means toward further accuracy assessment of the map.

Because the partial accuracy assessment was conducted prior to the completion of the entire map coverage, it was impossible for us to select randomly from the entire range of polygons across the mapping area. Thus, what we have presented here is more an accuracy assessment of a particular vegetation series on a particular photo portion of the park. Although in most cases the interpretableness of a given vegetation type does not vary from area to area, depending on what other associated vegetation types exist adjacent to a given vegetation type, the same type may be more easy to interpret in one part of the park than in another. A more reliable presentation would involve a random selection of polygons of other vegetation types anywhere in the park. With the completed vegetation database, this would be possible and preferable. In the following table we have included calculations for a park-wide assessment of all vegetation types including the five that have had partial accuracy assessment in June 1997.

Table 5: Predicted calculations for p, d and n for park-wide accuracy assessment.

series with code	**predicted p value**	**predicted d value**	**predicted sample size (n)**
Active dunes and sand fields 2201000	insufficient polygons	-	-
California Buckwheat 3204000	0.75	0.15	33
Wright’s buckwheat 3204100	0.75	0.15	33
Scalebroom 3207000	insufficient polygons	-	-
California buckwheat-white sage 3210000	0.70	0.15	36
Deerweed 3218000	0.75	0.15	33
Creosote bush 3301000	0.75	0.15	33
Blackbush 3302000	0.80	0.15	28
Brittlebush 3303000	0.80	0.15	28

Desert Sunflower 3303200	0.75	0.15	33
Catclaw acacia 3304000	0.80	0.15	28
Teddybear cholla 3305000	0.70	0.15	36
Burrobush 3306000	0.80	0.15	28
Fagonia 336100	0.75	0.15	33
Caesalpinia 3306200	insufficient polygons	-	-
Mojave Yucca 3307000	0.75	0.15	33
Desert Agave 3307500	0.85	0.15	22
Nolina 3308000	insufficient polygons	-	-
Ocotillo 3309000	0.70	0.15	36
Elephant Tree 3312000	insufficient polygons	-	-
Creosote bush-burrobush 3314000	0.80	0.15	28
Desert Lavender 3319000	0.70	0.15	36
Cheesebush 3320000	0.80	0.15	28
Creosote bush-Mojave yucca 3321000	0.80	0.15	28
Desert apricot 3322000	0.75	0.15	33
Big sagebrush 3510000	0.75	0.15	33
Chrysothamnus teretifolius 3533000	insufficient polygons		
Iodinebush 3612000	insufficient polygons	-	-

Bush seepweed 3622000	insufficient polygons	-	-
Fourwing saltbush 3631000	insufficient polygons	-	-
Allscale 3634000	0.75	0.15	33
Mixed saltbush 3636000	insufficient polygons	-	-
Quailbush 3637000	insufficient polygons	-	-
Chamise 3710000	0.80	0.15	28
Chamise-cupleaf ceanothus 3710500	0.65	0.15	39
Chamise-Eastwood manzanita 3710600	0.70	0.15	36
Deerbrush 3720600	insufficient polygons	-	-
Cupleaf ceanothus (in Cupleaf-fremontia-oak) 3721200	insufficient polygons		
Eastwood Manzanita 3730200	0.80	0.15	28
Pink-bracted manzanita 3730800	0.75	0.15	33
Point-leaf--pink-bracted Manzanita 3730900	0.75	0.15	33
Interior live oak (chaparral) 3740100	0.75	0.15	33
Mixed scrub oak 3740600	0.80	0.15	28
Scrub oak 3740700	0.70	0.15	36
Muller oak 3741500	0.80	0.15	28
Redshank 3750100	0.85	0.15	22
Redshank-chamise	0.85	0.15	22

3750300			
Sugarbush 3780100	0.80	0.15	28
Skunkbush 3780200	insufficient polygons	-	-
Recently burned chaparral 3799900	insufficient polygons	-	-
Big galletta 4103000	insufficient polygons	-	-
Saltgrass 4120000	insufficient polygons	-	-
Cheatgrass 4202000	insufficient polygons	-	-
Red brome 4202500	insufficient polygons	-	-
Introduced perennial grassland 4205000	insufficient polygons	-	-
Schismus 4209000	insufficient polygons	-	-
Montane meadow 4531000	insufficient polygons	-	-
Mexican rush 4550000	insufficient polygons	-	-
Bulrush 5210100	insufficient polygons	-	-
Fremont cottonwood 6113000	0.85	0.15	22
Arroyo willow 6120100	0.80	0.15	28
Sycamore 6131000	insufficient polygons	-	-
White alder 6142000	insufficient polygons	-	-
Mesquite 6151000	0.90	0.15	16
Fan palm 6152000	insufficient polygons	-	-
Ironwood-smoketree-blue palo verde 6153000	insufficient polygons	-	-
Blue palo verde 6154000	0.85	0.15	22
Desert willow 6155000	0.80	0.15	28

Ironwood 6156000	0.80	0.15	28
Smoketree 6157000	0.80	0.15	28
Narrowleaf willow 6311000	insufficient polygons	-	-
Mulefat 6350000	insufficient polygons	-	-
Baccharis emoryi 6352000	insufficient polygons	-	-
Broom baccharis 6353000	insufficient polygons	-	-
Arrow weed 6371000	insufficient polygons	-	-
Tamarisk 6381000	insufficient polygons	-	-
California black oak 7101000	0.85	0.15	22
Canyon live oak 7105000	0.80	0.15	28
Coast live oak 7106000	0.85	0.15	22
California bay 7410000	insufficient polygons	-	-
Birchleaf mountain mahogany 7610000	0.75	0.15	33
Curl-leaf mountain mahogany 7620000	insufficient polygons	-	-
Jeffrey pine 8702000	0.90	0.15	16
Parry pinyon pine 8703000	insufficient polygons	-	-
Single-leaf pinyon pine 8704000	0.85	0.15	22
Coulter pine 8721000	0.85	0.15	22
California juniper 8910000	0.80	0.15	28

Sandy to cobbly wash bottom 9990001	0.90	0.15	16
Gypsum 9990002	0.80	0.15	0.15
Mudhills 9990003	0.90	0.15	16
Low elevation rock outcrop 9990004	0.90	0.15	16
Upper elevation rock outcrop 9990005	0.90	0.15	16
Development 9990006	0.90	0.15	16
Playa 9990007	insufficient polygons	-	-
Open water 9990008	insufficient polygons	-	-

Based on this table a total of 1547 accuracy assessment samples would be required to sample the 58 mapping units numerous enough to provide an adequate sample size for the predictions of p and d values. 42% (39 out of 94) mapping units have an insufficient number of polygons to be assessed without visiting every polygon. It is clear that the amount of effort for a complete accuracy assessment would be substantial. We suggest that if the park would like a more thorough understanding of the map accuracy that they prioritize the types they are most interested in and work on those first. We also suggest that the polygons for assessment be stratified by accessibility using a selection process similar to that described in the methods above, using the entire park's vegetation layer and selecting polygons based on a minimum distance from road-accessible points.

Conclusions and Recommendations

This is the first extensive vegetation mapping effort undertaken based on the following principle: Field data drives the classification; this classification is the basis of the aerial photo interpretation, which, in turn, is used to describe vegetation polygons in a GIS environment. Many other mapping projects of a similar nature are now being initiated for large areas of California and elsewhere in the United States. Because of this, we believe it important to discuss our observations and recommendations. This section is organized by topics in the order of how we envision them to fall into the idealized sequence of events.

I. Time and Budget

The original contract was written to be completed in 15 months. The contractor for this project had to apply for two contract extensions (a total of 8 extra months) to complete this project. Reasons for this are varied and include:

- inadequate time to accumulate, analyze, and enter information,
- difficulties in communication and information exchange between contractor and contractee,
- additional responsibilities for all parties representing the contractor,
- new techniques such as those included in this project require some trial and error time

We recommend that in future efforts of this nature and extent (areas >500,000 acres) that at least two years be allotted for completion of the contract. This is a general rule of thumb and will vary based on a number of factors. Other vegetation mapping projects of a similar magnitude such as those ongoing in Yosemite, Point Reyes-Golden Gate National Recreation Area, and the Mojave Desert are allowing 2-3 years for completion and are budgeted from 3 to 13 times higher than this project. The budget for this project was adequate to pay for travel to and from the project area, accommodation and food, and salary for the two scientific aids hired to work full time on the project. The additional time and labor from two of the principle investigators and the assistance from other field and office staff was not compensated and the other principal was partially compensated but this was outside of the contract. If full compensation was made we expect the budget to have increased by 2-3 times.

A project such as this will proceed fastest if:

1) the administrative bureaucracies are expedient in facilitating contractual agreements,
2) there are staff in all critical roles dedicated or largely dedicated to the project,
3) the quantitative classification for the area in question is well developed,
4) there is high quality digital and photo information available at the onset for purposes of sample allocation, polygon delineation, and orientation,
The first of these four points is beyond our level of expertise. However, we will describe the others in more detail.

The only wholly dedicated staff in this project was the two scientific aids. We felt we made a good decision by involving them in all aspects of the project from field work to GIS processing and production. We believe that for detailed integrated processes such as large scale vegetation mapping it is best to have an integrated staff who is largely dedicated to the project and who understands (by some first-hand experience) the significance and value of all the roles in the project. In our case one principal had about 35% of her time devoted to the project while all other staff had between 10 and 25% of their yearly time dedicated. The result was that as other responsibilities waxed and waned, the amount of time for the map did the same. More detail is given below to the importance of resident experts in different fields. The shifting cast of characters in certain roles (particularly GIS related mentors) sometimes caused significant slowing of progress.

The time spent on field sampling is inversely proportional to the amount of existing quantitative vegetation data and the level of development of the classification. The paucity of quantitative classification work in the Colorado Desert necessitated a large amount of standardized vegetation sampling and subsequent analysis before the map could be made. Multiple samples had to be taken from all major vegetation series to develop a data set large enough to substantiate the existence of each series and association that was mapped. The more well known the vegetation is via quantitative sampling, the less effort has to be put into a sampling program.

II. Technical Needs and Considerations

1. Project Area Boundary The mapping area boundary must be well defined before the photos are delineated. Having an agreed upon boundary will preclude spending time on the delineation of an area which is later determined to be outside the map area. In our contract a specific boundary of the park was known, but the boundary of the environs we were to map was not specified, and only generally discussed in the contract. Negotiations between the park, San Diego County, and the contractor were necessary to solidify the boundary of the project. The final environs boundary was not agreed upon until well after the onset of the project and resulted in unnecessary delineation of large areas surrounding the park. In general, if existing information such as the park boundary layers are to be received from other agencies, a specific list of products and delivery date should be agreed upon and observed.

2. Sample Allocation As discussed in the sample allocation section, the optimal gradsect design for this project could not proceed, because adequate GIS coverages for influential environmental variables did not exist. A means to allocate samples based on environmental information in GIS coverages such as geology, soils, climate, and topography is needed to accomplish this. The *ad hoc* approach used for sample allocation, based largely on topography and intuitive field experience, was not likely to have been as efficient as a stratified random sample allocation based on a GIS analysis of geology, climate, soils, and other potential variables. We felt that at the end of the project several distinctive vegetation types, which had showed up after polygon attribution was complete, were not represented in the sampling scheme. Although most of these were rare and of small extent, we felt that with a more non-biased, ecologically-driven sampling scheme we would have captured more of them and thus have a more complete data-driven classification upon which to base the map.

In lieu of the best possible initial GIS layers for sampling, more time available for field data collection would have been useful. Ideally it would be useful to have a preliminary polygon labeling phase after the second field season of sampling so that examples of all polygons that did not match with a signature of a known sampled type could be visited and sampled.

3. Recent aerial photography Access to recent aerial photography would afford up to date depiction of vegetation. Most of the aerial photographs used in this project were taken in 1992. These photos limited our ability to depict current conditions including the effects of recent fires, management activities such as invasive exotic plant control projects, and land use changes such as development.

4. High Quality Photography of Uniform Scale Uniform spatial and temporal resolution of photographs is important for the development of a uniform mapping product. Such uniformity enables equal scale polygon definition with the most appropriate resolution for the classification level required. In our case we had photos taken at two different base scales (1:24,000 and 1:48,000), two different contact print formats (9X9" and 18X18"), and three different dates at different times of the year (June through October 1992-1996). The differences between these formats and dates gave us some difficulties in discerning signatures and accurately depicting polygons that crossed into photos of different scales and/or dates.

Interpretation was easiest for the 1:24,000 scale 18X18" Fall 1992 photos. Air quality during the Fall '92 flights was excellent and provided crisp high resolution contact prints. Although the low angle light at that time of the year produced shadowing on the northeast facing slopes, we found this useful to identify signatures of certain desert vegetation types and isolate environmental factors such as slope exposure that likely determine distribution of vegetation. Fall vegetation patterns emphasize the perennial and not the spring annual vegetation of the desert, and thus are more useful for a map depicting vegetation defined by perennial species only.

The scale of the photos reflects our ability to discern vegetation at different levels in the classification hierarchy. A scale of 1:24,000 is appropriate for some associations and most series, but not high enough resolution for all associations.

Another issue of importance is to have sufficient overlap (ca. 60%) between all photos to afford the best possible delineation of the least distorted center of each photograph. Our photos did not have consistent overlap and in certain areas overlapped less than 10%. The degree of overlap also has bearing on edge matching and georeferencing of the vegetation coverages in the GIS processing stage of the project.

5. Conversion of Vegetation Polygons into the GIS. Determining the best way to convert polygon delineations into GIS coverages requires careful consideration and depends on several factors including staff experience and the level of detail of the vegetation map. In our case, we had detailed delineations, little experience with scanning, and moderately experienced digitizers. Under these conditions, we recommend digitizing polygons into the GIS using a digitizing tablet over scanning. Scanning posed several challenges for us. Experimentation was required to determine the best media to use for scanning images into the GIS and to determine which settings to use on the scanner itself. Because the scanner could only be accessed on a limited basis, scheduling time to use it posed additional difficulty. Once scanning of vegetation polygons into the GIS was complete, a substantial amount of editing was required which necessitated on-screen and tablet digitizing. Since digitizing was eventually needed to correct inadequately scanned parts of the image, we think it would have been more effective to digitize all of the polygons without scanning them first. By digitizing instead of scanning, the process of transferring vegetation polygons from photographs to a transparent medium would also not be required.

6. Georeferencing The methods used in this project to georeference vegetation polygons

required the manual identification of ground control points on both the aerial photographs and on digital imagery. Using these control points, the vegetation polygon coverages were georeferenced and corrected for distortion in a process commonly known as "rubber-sheeting". More sophisticated methods using mathematical algorithms based on accurately calibrated aerial photographs could be employed to correct distortion in a more systematic fashion. In addition, global positioning systems used to georeference aerial photographs as they are taken would help expedite georeferencing of vegetation polygons.

7. Effective Mapping Area Converting photo delineations into digital polygon coverages is a process that involves many different steps (see GIS methods). One of the first steps in the process should be the definition of "effective mapping areas" (EMA's) for each photograph. These four-sided areas were manually defined as boundaries for each photograph within which delineation would occur. The effective mapping areas were centered to minimize distortion, and matched to EMA's of adjacent photographs to provide a minimal degree of overlap between them. Although it was not done until near the end of the project, it would have been useful early in the project to develop a separate digital coverage of the effective mapping areas within the project area to assist delineation, digitizing, edge-matching, mosaicking, and attribution.

8. Global Positioning Systems Most vegetation sample points and some vegetation polygons were georeferenced using Global Positioning Systems (GPS). Experience in GPS software, specifically in converting points gathered to real world coordinates, familiarity with GPS field methods (use of rovers and base stations), and expertise with ARC/INFO software is essential. If there is no one who can be dedicated to the project with this knowledge it would be beneficial that they be "on call" and be available to help solve problems and answer questions. A great deal of time was spent manipulating and post-processing GPS information in this project. Federal projects such as National Park and other USGS-BRD directed vegetation mapping make use of highly accurate GPS units which correct signals as they are collected and do not require post-processing. These instruments are currently restricted to federal government use. It would be very valuable to have access to these efficient machines for other state and local government-based vegetation mapping projects.

III. Vegetation Sampling and Analysis and the Link with Attribution

In general, the process of collecting samples worked well given the limitations of the improvised gradsect methodology. The subjective photo-based selection of samples precluded some statistical analysis on the variance and other features of the data set, but largely improved the efficiency of accessing and representing the vegetation with as few samples as possible. For classification purposes the non-random selection of polygons did not inhibit the value of the data. However, some modification in the processing of vegetation data following collection would be valuable.

Data entry of the field samples into a standardized database for archiving and downloading into analytical programs was not done, because the database could not be developed in a timely manner. If this had been done, archiving and accessing this information would have been easier. We did not have the time to perform analysis of the environmental variables collected. Thus, no statistical correlations were investigated between the composition of the vegetation samples and the environments in which they were found. If this had been done, we would have been able to use the correlations to help us develop a more accurate assignment of vegetation types to polygons without distinctive photo signatures.

One of the most challenging portions of many mapping projects is to find repeatable ways to link the classification developed through on-the-ground sampling with aerial photo-based recognition of vegetation. This is because the rules developed for classification can't always match the rules developed for definition of polygons via remote sensing. However, because the MCV classification is largely based on identifying the dominant species present, and dominant species are those usually most discernable from aerial photos, the challenge was usually not insurmountable. This was particularly true at the series level of the classification. More difficulties did arise with attempts to determine associations from photo signatures because associations are often based on the presence of indistinct under story species.

IV. Validation of Vegetation Signatures

Following the development of the classification, a vegetation key (see results section) was developed to assist in accuracy assessment and in final determination of the polygon attributes. Because of the length of time it took to develop the classification and the key, there was very little time to familiarize ourselves with it before launching into the final attribution and accuracy assessment phases. We all agree that prior to final attribution several weeks of validation based on driving roads with key and polygon map in hand would have been extremely valuable in building accuracy and confidence into the final attribution phase.

V. Final Polygon Attribution

Among the most time-consuming parts of the project was the manual labeling of the 23,000+ initial polygons. Using three different people this process took about 7 months to complete. Manual entry of information was restricted to the primary classification units (series and associations), and a few other key variables (see Polygon Delineation and Labeling section). Automated procedures were developed for entry of the cross-walk, map symbology, color scheme, and other attributes. Automation of the entry of series and association descriptors based on modeling of vegetation sampling and environmental data would have been preferable for several reasons. It would have provided a more uniform systematic and less biased assignment of names to the map polygons, it would have greatly reduced error resulting from keystroke data entry and mis-identification of polygons (much time was spent at the end of the project correcting data entry errors and omissions), and following initial preparation, it would have taken a fraction of the time as manual entry.

However, it is likely that the only way efficient automation of vegetation data entry could take place is to have spent far more time on developing a model based on detailed and extensive field data in conjunction with detailed and synoptic GIS coverages of important environmental variables. Predictive modeling of the distribution of vegetation in the desert is a new untested field. In addition to the above requirements, it requires a complete quantitative classification and a set of well-established correlations between environmental variables and vegetation types. It is likely that correlations will not be strong between measurable and mappable environmental variables and some vegetation types. Therefore, the best we could hope for is a partial automation process where those vegetation types with strong correlations to certain environmental features that are available in GIS coverages (such as aspect, elevation, substrate, soil, rainfall, etc.) could be automatically attributed via a sequence of logic statements developed for the computer, whereas those with weak correlations would still have to be manually entered via photo interpretation. It is likely that the accuracy and time saved in even a partial automation would be significant and warrants investigation.

Clearly an automation process was not possible for labeling the primary vegetation units in this project. However, some steps could have been taken to diminish data entry errors. One would be to have developed a vegetation attribute database structure which minimized the entry of any inappropriate keystroke combinations through automated error checking and validation. At the least we recommend doing this for future mapping efforts.

VI. Quality Control

The entire project could have benefitted from a more formal quality control process. As we neared completion of the digital coverage we came across errors from time to time. We then resolved to perform quality control on the numerical coding and attribution of polygons. Following tedious checking and double-checking we realized that it would have been much more efficient to have a quality control check along each step of conversion from physical delineation and attribution to final digital product. The main error that occurred in the attribution process was mis-identification of polygons. In many instances there are many small polygons very close together. When coverages are printed on transparent overlays with polygon numbers (labels) appearing on polygons, numbers can overlap each other or into adjoining polygons where they can be difficult to see. This could have been resolved if attributers had regular access to digital coverages where they could accurately determine polygon numbers.

VII. Value-Added Products

With more time for the project valuable additional work could be done associated with the mapping effort. For example the GPS-based threat and impact information could have been further developed into a modeling exercise that would predict the likelihood of various impacts in various parts of the mapping area. Questions about threats and intensities of threats to various vegetation types could then be more effectively answered.

Concluding Statement

Despite the above suggestions for improvement, we believe the value of this mapping project is great. The largest State Park in California, and a significant part of the Colorado desert of California is now mapped to a higher degree of specificity than any other large part of the State.

This map will be available to resource managers for a number of purposes from modeling the distribution of rare plant and animal species to selecting appropriate transportation routes, and monitoring change in the park's vegetation over time. The quantitative, testable classification used can be linked with the same classification which is used state-wide by DFG and nationally by NPS and other agencies. This project has also provided valuable information for future mapping projects of this kind. It has been a fascinating experience and often a joy to do this work. We thank DPR for the opportunity and the trust it has given us to complete this task.

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Appendix 1: Field Sampling Forms:

Anza Borrego Desert State Park Vegetation Map
Accuracy Assessment Form for Series Determinations

Polygon Number ____________________ Date ______________

Field Assessed Vegetation Type:

Name	Code	Cover Value(LMH)
____________________	______________	________

List Top 6 Species in Polygon with Approximate Cover Values (%):

________________________ |____ ________________________ |____
________________________ |____ ________________________ |____
________________________ |____ ________________________ |____

Problems with Interpretation:

_____ Cannot key out. Elaborate: ________________________________

_____ Polygon is more than one type (type with greatest cover in poly should be entered above).

Types: ______________ ______________ ______________

_____ Other: ________________________________

Do you think the vegetation has changed since Fall 1992? Y____ N____ If so how? What has changed?

____
____
____
____

For office use only

Photo Interpreted Type:

Name	Code	Cover Value(LMH)
____________________	______________	________

Accuracy:

_____Correct _____ Incorrect

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Appendix 2: Instructions for Accuracy Assessment Sampling and Accuracy Assessment Forms

The basis for this type of assessment is to collect the minimum amount of data that will support the correct identification of any vegetation type in the mapping area. You will need a copy of the key to vegetation types of Anza Borrego (pages 28-51 in report). Familiarize yourself with the key before you take it to the field. Use the basic methodology outlined in the accuracy assessment discussion of the report for a possible way of selecting polygons (pages 73-78). If you are doing a park-wide assessment of selected vegetation types see suggestions on page 83.

Once you have selected the vegetation polygon you wish to assess, enter the polygon and perform a brief reconnaissance. If the polygon is small this may be done from a single prominent location. If the polygon is large a rapid walk through the polygon to a prominent location may be necessary. Note the overall composition of the vegetation. Note also the uniformity of the vegetation. We have developed a form that will establish the overall vegetation of the polygon by requesting a list of the six most dominant species. Prior to performing any accuracy assessment using this form you should be familiar and comfortable with estimating vegetation cover in the desert. If this is to be a multi-person effort we recommend that you work as a group and practice estimating cover and plant identification before you send individuals out to collect data. Group calibration is an important technique for arriving at reliable and consistent cover estimates. Following the estimation of the cover of the six species write the name of the series and its code and cover value (1=0-15%, 2=15-50%, 3=>50%).

In addition to the six species cover values, the form also attempts to assess reasons for misclassification of a polygon. These reasons may be categorized as:
1) incompleteness of the classification (the key is insufficient to identify the vegetation in question), 2) problems with the delineation of the polygon (the vegetation within the polygon is more than one type), and/or 3) problems based on the recent site history of the polygon (something has changed the appearance of the vegetation since the date of the aerial photos used for vegetation interpretation). Three questions are posed to address these potential problems. Please fill out the detailed response if any of these questions are answered affirmatively. Detailed answers to these questions will assist in the office assessment of the correctness of interpretation of the polygon.

The entire form should be filled out as rapidly as possible. For the partial accuracy assessment reported on in this report we requested that the field crew spend no more than 10 minutes filling out each form. The desired duration will vary depending on how many polygons you wish to visit in a given time frame.

The box at the bottom of the form should be filled out by a person who has complete understanding of the vegetation classification and access to the GIS data files for the polygons in question. This person should be impartial and ideally not a member of the field accuracy assessment team. This person should review the details of each form and make their own independent judgement of the correct name of the vegetation type for each polygon assessed. In some cases rapid assessment on the part of the field crew may have overlooked a key point in identification.

Appendix 3:
SPECIES CODES FOR TWINSPAN ANALYSIS
(revised May 30, 1997)

Species #	Species	Species code
1	*Acacia greggii*, ground	ACGR-G
2	*Acacia greggii*, shrub	ACGR-S
3	*Acacia greggii*, tree	ACGR-T
4	*Acalypha californica*, s - considered for listing but rejected	ACCA-S
5	*Acamptopappus sphaerocephalus*, g	ACSP-1G
6	*Acamptopappus sphaerocephalus*, s	ACSP-1S
7	*Achnatherum coronatum*, g	ACCO-G
8	*Achnatherum coronatum*, s	ACCO-S
9	*Achnatherum speciosum*, g	ACSP-2G
10	*Achnatherum speciosum*, s	ACSP-2S
11	*Achillea milefolium*, g	ACMI-G
12	*Adenophyllum porophylloides*, g	ADPO-G
13	*Adenophyllum porophylloides*, s	ADPO-S
14	*Adenostoma fasciculatum*, g	ADFA-G
15	*Adenostoma fasciculatum*, s	ADFA-S
16	*Adenostoma sparsifolium*, s	ADSP-S
17	*Adenostoma sparsifolium*, t	ADSP-T
18	*Agave deserti*, g	AGDE-G
19	*Agave deserti*, s	AGDE-S
20	*Agave deserti*, t	AGDE-T
21	*Agoseris grandiflora*, g	AGGR-G
22	*Agoseris grandiflora*, s	AGGR-S

23	*Allenrolfea occidentalis*, g	ALOC-G
24 *	*Allenrolfea occidentalis*, s	ALOC-S
25	*Ambrosia dumosa*, g	AMDU-G
26	*Ambrosia dumosa*, s	AMDU-S
27	*Amelanchier utahensis*, s	AMUT-S
28 *	*Amorpha californica*, s	AMCA-S
29 *	*Apium graveolens*, g	APGR-G
30	*Arabis perennans*, g	ARPE-G
31	*Arabis perennans*, s	ARPE-S
32	*Arabis pulchra*, s	ARPU-S
33	*Arceuthobium* sp. (glandulosa -- CR??), s	ARC-1S
34	*Arceuthobium* sp. (glandulosa -- CR??), t	ARC-1T
36	*Arctostaphylos glandulosa adamsii*, g	ARGLA-G
37	*Arctostaphylos glandulosa adamsii*, s	ARGLA-S
38 *	*Arctostaphylos glandulosa*, s	ARGL-1S
39	*Arctostaphylos glauca*, s	ARGL-2S
40	*Arctostaphylos pringlei*, s	ARPR-S
41	*Arctostaphylos pringlei*, t	ARPR-T
42	*Arctostaphylos pungens*, g	ARPU-1G
43	*Arctostaphylos pungens*, s	ARPU-1S
44	*Arctostaphylos pungens, t*	ARPU-1T
45 ***	*Argemone munita*, g	ARMU-G
46	*Aristida* sp. Unk (annual native), g	ARI-1G
47 *	*Aristida* sp. Unk (perennial), g	ARI-2G
48	*Aristida purpurea*, g	ARPU-2G
49	*Aristida purpurea*, s	ARPU-2S

50	*Aristida purpurea parishii*, g	ARPUP-G
51	*Aristida purpurea parishii*, s	ARPUP-S
52	*Artemisia douglasiana*, g	ARDO-G
53	*Artemisia dracunculus*, g	ARDR-G
54	*Artemisia dracunculus*, s	ARDR-S
55	*Artemisia ludoviciana, g*	ARLU-G
56	*Artemisia ludoviciana*, s	ARLU-S
57	*Artemisia ludoviciana incompta, g*	ARLUI-G
58	*Artemisia tridentata*, g	ARTR-G
59	*Artemisia tridentata*, s	ARTR-S
60	*Artemisia tridentata vaseyana*, g	ARTRV-G
61	*Artemisia tridentata vaseyana*, s	ARTRV-S
62	*Asclepias* sp. Unk, g	ASC-1G
63	*Asclepias* sp. Unk, s	ASC-1S
64	*Asclepias albicans*, s	ASAL-S
65	*Asclepias californica*, g	ASCA-G
66 *	*Asclepias fasciculata*, s	ASFA-S
67 *	*Asclepias subulata*, s	ASSU-S
68	*Astragalus crotalariae*, g RARE LIST 4	ASCR-G
69 *	*Astragalus douglasii*, g	ASDO-G
70	*Astragalus douglasii parishii*, g	ASDOP-G
71	*Atriplex canescens*, g	ATCA-G
72	*Atriplex canescens*, s	ATCA-S
73	*Atriplex confertifolia*, s	ATCO-S
74	*Atriplex hymenelytra*, g	ATHY-G
75	*Atriplex hymenelytra*, s	ATHY-S

76	*Atriplex lentiformis, s*	ATLE-S
77	*Atriplex polycarpa*, g	ATPO-G
78	*Atriplex polycarpa*, s	ATPO-S
79	*Avena barbata* (exotic annual), g	AVBA-G
80	*Avena barbata* (exotic annual), s	AVBA-S
81	*Avena fatua* (exotic annual), g	AVFA-G
82	*Avena fatua* (exotic annual), s	AVFA-S
83	*Baccharis brachyphylla*, s	BABR-S
84	*Baccharis emoryi, g*	BAEM-G
85 *	*Baccharis emoryi*, s	BAEM-S
86	*Baccharis salicifolia*, s	BASA-1S
87	*Baccharis salicifolia*, t	BASA-1T
88 *	*Baccharis sarothroides*, s	BASA-2S
89	*Baccharis sergiloides*, s	BASE-S
90	*Bebbia juncea*, g	BEJU-G
91	*Bebbia juncea*, s	BEJU-S
92	*Bebbia juncea aspera*, s	BEJUA-S
93	*Bernardia myricifolia*, g	BEMY-G
94	*Bernardia myricifolia*, s	BEMY-S
95 **	*Bloomeria crocea*, g	BLCR-G
97	*Brandegea bigelovii*, g	BRBI-G
98	*Brandegea bigelovii*, s	BRBI-S
99	Brassicaceae Unk, g	BRA-1G
100	Brassicaceae Unk, s	BRA-1S
101	*Brassica tournefortii*, g	BRTO-G
102	*Brassica tournefortii*, s	BRTO-S

103	*Brickellia californica*, s	BRCA-S
104	*Brickellia microphylla*, g	BRMI-G
105	*Brickellia microphylla*, s	BRMI-S
106 *	*Bromus arenarius* (exotic annual), g	BRAR-G
107	*Bromus carinatus* (exotic annual), s	BRCA-S
108	*Bromus diandrus* (exotic annual), g	BRDI-G
109	*Bromus diandrus* (exotic annual), s	BRDI-S
110 *	*Bromus madritensis rubens* (exotic annual), g	BRMAR-G
111	*Bromus tectorum* (exotic annual), g	BRTE-G
112	*Calochortus* sp. Unk, g	CAL-1
113	*Calochortus concolor*, s	CACO-S
114	*Calochortus splendens*, g	CASP-G
115	*Calystegia macrostegia*, g	CAMA-G
116	*Camisonia* sp. Unk (native annual), g	CAM-1
117	*Camisonia boothii* (native annual), g	CABO-G
118	*Carex alma*, s	CAAL-S
119 *	*Castilleja* sp. Unk, s	CAS-1
120	*Castilleja foliosa*, g	CAFO-G
121	*Castilleja foliosa*, s	CAFO-S
122	*Castilleja minor spiralis*, g	CAMIS-G
123	*Castilleja minor spiralis*, s	CAMIS-S
124	*Ceanothus cuneatus*, s	CECU-S
125	*Ceanothus greggii*, g	CEGR-G
126	*Ceanothus greggii*, s	CEGR-S
127	*Ceanothus leucodermis*, g	CELE-G
128 **	*Ceanothus leucodermis*, s	CELE-S

129	*Cercis occidentalis*, s	CEOC-S
130	*Cercocarpus betuloides*, g	CEBE-G
131	*Cercocarpus betuloides*, s	CEBE-S
132	*Cercocarpus betuloides, t*	CEBE-T
133	*Cercocarpus mInutiflora*, g	CEMI-G
134	*Cercocarpus mInutiflora*, s	CEMI-S
135	*Chaenactis parishii*, g	CHPA-1G
136	*Chamaesyce polycarpa*, g	CHPO-G
137	*Cheilanthes covillei*, g	CHCO-G
138	*Cheilanthes parryi*, g	CHPA-2G
139	*Chilopsis linearis*, g	CHLI-G
140	*Chilopsis linearis*, s	CHLI-S
141	*Chilopsis linearis*, t	CHLI-T
142 *	*Chorizanthe* (native annual), g	CHO-1
143	*Chrysothamnus paniculatus*, s	CHPA-3S
144	*Chrysothamnus teretifolius*, g	CHTE-G
145	*Chrysothamnus teretifolius*, s	CHTE-S
146 ***	*Cirsium occidentale californicum*, g	CIOCC-G
147	*Cleomella obtusifolia*, s	CLOB-S
150	*Coleogyne ramosissima*, g	CORA-G
151	*Coleogyne ramosissima*, s	CORA-S
152	*Croton californicus*, g	CRCA-G
153	*Croton californicus*, s	CRCA-S
154	*Cryptantha* sp. Unk, g	CRY-1
156	*Curcurbita palmata*, g	CUPA-G
157	*Curcurbita palmata*, s	CUPA-S

158	*Curcurbita poetidissima*, g	CUPO-G
159	*Cuscuta californica*, g	CUCA-G
160 *	*Cuscuta californica*, s	CUCA-S
161	*Cuscuta californica californica*, g	CUCAC-G
162	*Cuscuta californica californica*, s	CUCAC-S
163	*Cynodon dactylon**, g	CYDA-G
164	*Cyperus parishii*, g	CYPA-G
165	*Datura wriightii*, g	DAWR-G
166	*Datura wriightii*, s	DAWR-S
167	*Dendromecon rigida*, s	DERI-S
168	*Descurania* sp. Unk, g	DES-1
169	*Descurania sophia*, g	DESO-G
170	*Dichelostemma capitatum*, s	DICA-S
171	*Distichlis spicata*, g	DISP-G
174 *	*Ditaxis lanceolata*, g	DILA-G
175	*Ditaxis neomexicana*, g	DINE-G
176	*Dudleya abramsii*, g	DUAB-G
177	*Dudleya saxosa*, g	DUSA-G
178	*Dudleya saxosa*, s	DUSA-S
179	*Dudleya saxosa aloides*, g	DUSAA-G
180 *	*Echinocereus engelmannii*, g	ECEN-G
181	*Elymus elymoides*, g	ELEL-G
182	*Elymus elymoides*, s	ELEL-S
183 **	*Elymus glaucus*, g	ELGL-G
185 *	*Eleocharis montevidensis*, g	ELMO-G
186	*Encelia farinosa*, g	ENFA-G

187	*Encelia farinosa*, s	ENFA-S
188	*Encelia frutescens*, g	ENFR-G
189	*Encelia frutescens*, s	ENFR-S
190	*Encelia actoni (virginensis var actoni)*, g	ENVI-G
191	*Encelia actoni (virginensis var actoni)*, s	ENVI-S
192 *	*Encelia actoni*, s duplicate used also	ENAC-S
193 *	*Ephedra aspera*, s	EPAS-S
194	*Ephedra californica*, g	EPCA-1G
195	*Ephedra californica, s*	EPCA-1S
196	*Ephedra fasciculata*, s	EPFA-S
197	*Ephedra nevadensis*, g	EPNE-G
198	*Ephedra nevadensis*, s	EPNE-S
199	*Ephedra trifurcata*, s	EPTR-S
200 *	*Ephedra virdis*, s	EPVI-S
201	*Epilobium canam latifolium*, g	EPCAL-G
202	*Epilobium cilatum*, g	EPCI-G
203	*Equisetum laevigatum*, g	EQLA-G
205	*Eriastrum sapphirinum*, g	ERSA-G
206	*Ericameria cuneata*, g	ERCU-G
207	*Ericameria cuneata*, s	ERCU-S
208	*Ericameria linearifolia*, g	ERLI-G
209	*Ericameria linearifolia*, s	ERLI-S
210	*Ericameria palmeri pachylepis*, g	ERPAP-G
211 **	*Ericameria palmeri pachylepis*, s	ERPAP-S
212	*Ericameria pinifollia*, g	ERPI-G
213	*Ericameria pinifollia*, s	ERPI-S

214	*Erigeron* sp. Unk, g	ERI-1
215	*Erigeron foliosus*, g	ERFO-G
216 *	*Erigeron foliosus, s*	ERFO-S
217 *	*Erigeron foliosus foliosus*, s	ERFOF-S
218	*Eriodictyon trichocalyx*, g	ERTR-G
219 *	*Eriodictyon trichocalyx*, s	ERTR-S
220	*Eriogonum elongatum elongatum*, g	ERELE-G
221	*Eriogonum elongatum elongatum*, s	ERELE-S
222	*Eriogonum fasciculatum*, g	ERFA-G
223	*Eriogonum fasciculatum*, s	ERFA-S
224	*Eriogonum fasciculatum poliofolium*, g	ERFAP-G
225	*Eriogonum fasciculatum poliofolium*, s	ERFAP-S
226	*Eriogonum inflatum deflatum*, g	ERIND-G
227	*Eriogonum inflatum deflatum*, s	ERIND-S
228	*Eriogonum inflatum inflatum*, g	ERINI-G
229	*Eriogonum inflatum inflatum*, s	ERINI-S
230	*Eriogonum plumatella*, s	ERPL-S
231	*Eriogonum wrightii membranaceum*, g	ERWRM-G
232	*Eriogonum wrightii membranaceum*, s	ERWRM-S
233	*Eriogonum wrightii nodosum*, g	ERWRN-G
234	*Eriogonum wrightii nodosum*, s	ERWRN-S
235	*Erioneuron pulchellum*, g	ERPU-G
236	*Eriophyllum confertiflorum*, g	ERCO-G
237	*Eriophyllum confertiflorum*, s	ERCO-S
238	*Eriophyllum confertiflorum laxiflorum*, g	ERCOL-G
240	*Erodium botrys*, g	ERBO-G

241	*Erodium cicutarium*, g	ERCI-G
242	*Erysimum capitatum*, g	ERCA-G
243	*Erysimum capitatum*, s	ERCA-S
244	*Euphorbia eriantha*, g	EUER-G
245	*Fagonia laevis*, g	FALA-G
246	*Ferocactus cylindraceus*, g	FECY-G
247	*Ferocactus cylindraceus*, s	FECY-S
248	*Fouquieria splendens*, g	FOSP-G
249	*Fouquieria splendens*, s	FOSP-S
250	*Fouquieria splendens*, t	FOSP-T
251	*Fraxinus velutina*, t	FRVE-T
252	*Galium* sp. Unk , g	GAL-1
253	*Galium andrewsii*, g	GAAN-1G
254	*Galium angustifolium*, g	GAAN-2G
255	*Galium angustifolium*, s	GAAN-2S
256	*Galium angustifolium angustifolium, g*	GAANA-G
257	*Galium angustifolium angustifolium*, s	GAANA-S
258	*Galium angustifolium borregoense*, s RARE LIST 1B	GAANB-S
259	*Galium stellatum*, g	GAST-G
260	*Galium stellatum*, s	GAST-S
261	*Galium stellatum eremicum*, g	GASTE-G
262	*Garrya flavescens*, s	GAFL-S
263	*Garrya flavescens*, t	GAFL-T
264	*Garrya flavescens flavescens, s*	GAFLF-S
265	*Garrya flavescens pallida*, s	GAFLP-S
266	*Garrya veatchii*, s	GAVE-S

267	*Gnaphalium* sp. Unk, g	GNA-1
268 *	*Gnaphalium californica*, g	GNCA-1G
269	*Gnaphalium canescens*, g	GNCA-2G
270	*Gnaphalium canescens*, s	GNCA-2S
271 *	*Gnaphalium canescens beneolens*, s	GNCAB-S
273	*Gutierrezia microcephala*, g	GUMI-G
274	*Gutierrezia microcephala*, s	GUMI-S
275	*Gutierrezia sarothrae*, g	GUSA-G
276	*Gutierrezia sarothrae*, s	GUSA-S
277	*Hazardia squarrosa*, g	HASQ-G
278	*Hazardia squarrosa*, s	HASQ-S
279	*Isocoma acradenia (Haplopappus acradenius)*, g	ISAC-G
280	*Isocoma acradenia (Haplopappus acradenius)*, s	ISAC-S
281 *	*Helianthemum scoparium*, s	HESC-S
282	*Helianthus gracilentus*, s	HEGR-S
283 *	*Helitropium curvassavicum oculatum*, g	HECUO-G
284 **	*Hoffmannseggia glauca*, g	HOGL-G
285	*Hymenoclea salsola*, g	HYSA-G
286	*Hymenoclea salsola*, s	HYSA-S
287	*Hypericum formosum scouleri*, g	HYFOS-G
288	*Hyptis emoryi*, g	HYEM-G
289	*Hyptis emoryi*, s	HYEM-S
290	*Isocoma acredenia eremophila*, s	ISACE-S
291	*Isocoma mensiesii, g*	ISME-G
292	*Isocoma mensiesii*, s	ISME-S
293	*Isocoma mensiesii mensiesii*, s	ISMEM-S

294	*Isomeris arborea*, s	ISAR-S
295 *	*Juncus* sp. Unk (broad leaf), g	JUN-1
296 *	*Juncus mexicanus*, g	JUME-G
297	*Juncus tenuis*, s	JUTE-S
298 *	*Juncus xiphioides*, g	JUXI-G
299	*Juniperus californica*, s	JUCA-1S
300 *	*Juniperus californica*, t	JUCA-1T
301	*Justicia californica*, s	JUCA-2S
302	*Keckiella antirrhinoides*, s	KEAN-S
303	*Keckiella ternata*, g	KETE-G
304	*Keckiella ternata*, s	KETE-S
305 *	*Koleria macrantha*, s	KOMA-S
306	*Krameria erecta*, g	KRER-G
307	*Krameria erecta*, s	KRER-S
308	*Krameria grayi*, g	KRGR-G
309	*Krameria grayi*, s	KRGR-S
310	*Langloisia mathewsii* (native annual), g	LAMA-G
311	*Lasthenia californica*, g	LACA-G
312	*Larrea tridentata*, g	LATR-G
313	*Larrea tridentata*, s	LATR-S
314	*Larrea tridentata*, t	LATR-T
315	*Lepidium lasiocarpum* (native annual), g	LELA-G
316	*Lepidiodactylon pungens hallii*, g	LEPUH-G
317 *	*Lessingia (Corethrogyne) filaginifolia*, g	LEFI-G
318	*Lomatium mohavense*, g	LOMO-G
319	*Lonicera subspicata*, g	LOSP-G

320	*Lonicera subspicata, s*	LOSU-S
321	*Lonicera subspicata johnstoni*, s	LOSUJ-S
322	*Lotus* sp. Unk (native annual), g	LOT-1
323	*Lotus argophyllus*, g	LOAR-G
324	*Lotus oblingifolius*, g	LOOB-G
325	*Lotus rigidus*, g	LORI-G
326	*Lotus rigidus*, s	LORI-S
327	*Lotus scoparius*, g	LOSC-G
328	*Lotus scoparius*, s	LOSC-S
329	*Lotus scoparius brevialatus*, g	LOSCB-G
330	*Lotus scoparius brevialatus*, s	LOSCB-S
331 *	*Lotus strigosus*, g	LOST-G
332	*Lupinus arizonicus* (annual), g	LUAR-G
333	*Lupinus excubitus*, g	LUEX-G
334	*Lupinus excubitus austromontanus*, g	LUEXA-G
335	*Lupinus latifolius*, s	LULA-S
336	*Lycium* sp. Unk, s	LYC-1
337	*Lycium andersonii*, s	LYAN-S
338	*Lycium brevipes*, s	LYBR-S
339	*Lycium cooperi*, s	LYCO-S
340	*Lycium fremontii*, s	LYFR-S
341	*Lyrocarpa coulteri palmeri*, g RARE LIST 4	LYCOP-G
342	*Lyrocarpa coulteri palmeri*, s RARE LIST 4	LYCOP-S
343	*Mammillaria dioica*, g	MADI-G
344	*Marah macrocarpus*, s	MAMA-S
345	*Marah macrocarpus macrocarpus*, s	MAMAM-S

346	*Medicago polymorpha*, g	MEPO-G
347	*Melica fructescens, g*	MEFR-G
348	*Melica fructescens*, s	MEFR-S
349	*Melica imperfecta*, g	MEIM-G
350	*Melica imperfecta*, s	MEIM-S
351	*Melilotus officinalis*, g	MEOF-G
352	*Melilotus officinalis*, s	MEOF-S
353	*Mimulus aurantuacus*, s	MIAU-S
354	*Mimulus cardinalis*, s	MICA-1S
355	*Mimulus guttatus*, g	MIGU-G
356	*Mirabilis bigelovii*, g	MIBI-G
357	*Mirabilis bigelovii*, s	MIBI-S
358	*Mirabilis californica*, g	MICA-2G
359	*Mirabilis californica*, s	MICA-2S
360	*Mirabilis multiflora*, g	MIMU-G
361	*Monardella nana nana*, g	MONAN-G
362	*Muhlenbergia porteri*, g	MUPO-G
363	*Muhlenbergia porteri*, s	MUPO-S
364	*Muhlenbergia rigens*, g	MURI-G
365	*Muhlenbergia rigens*, s	MURI-S
366	*Myriophyllum sibricum*, g	MYSI-G
367	*Nassella cernua*, s	NACE-S
368	*Nicotiana obtusifolia*, g	NIOB-G
369 *	*Nicotiana obtusifolia*, s	NIOB-S
370 *	*Nolina parryi*, s	NOPA-S
371 *	*Oenothera* sp. Unk (native annual), g	OEN-1

372	*Oenothera deltrides*, g	OEDE-G
373	*Olneya tesota*, s	OLTE-S
374	*Olneya tesota*, t	OLTE-T
375	*Opuntia acanthocarpa*, g	OPAC-G
376	*Opuntia acanthocarpa*, s	OPAC-S
377	*Opuntia basilaris*, g	OPBA-G
378	*Opuntia basilaris*, s	OPBA-S
379	*Opuntia basilaris basilaris*, g	OPBAB-G
380	*Opuntia basilaris basilaris*, s	OPBAB-S
381	*Opuntia bigelovii*, g	OPBI-G
382	*Opuntia bigelovii*, s	OPBI-S
383	*Opuntia clorotica*, g	OPCL-G
384	*Opuntia clorotica*, s	OPCL-S
385	*Opuntia echinocarpa*, g	OPEC-G
386	*Opuntia echinocarpa*, s	OPEC-S
387	*Opuntia erinecea*, g	OPER-G
388	*Opuntia fosbergii*, g	OPFO-G
389	*Opuntia ramosissima*, g	OPRA-G
390	*Opuntia ramosissima*, s	OPRA-S
391	*Orobanche californica feudgei*, g	ORCAF-G
392	*Orobanche fasciculata*, g	ORFA-G
393	*Pellaea mucronata*, g	PEMU-G
394	*Pellaea mucronata mucronata*, g	PEMUM-G
395	*Pellaea mucronata californica*, g	PEMUC-G
396	*Pennisetum setaceum*, s	PESE-S
397	*Penstemon* sp. Unk, s	PEN-1

398	*Penstemon centranthifolius*, g	PECE-G
399	*Penstemon centranthifolius*, s	PECE-S
400	*Penstemon clevelandii*, g	PECL-G
401	*Penstemon clevelandii*, s	PECL-S
402	*Penstemon spectabilis*, g	PESP-G
403	*Penstemon spectabilis*, s	PESP-S
404	*Pentagramma triangularis*, g	PETR-G
405	*Petalonyx thurberi*, g	PETH-G
406 *	*Petalonyx thurberi*, s	PETH-S
407 **	*Peucephyllum schottii*, s	PESC-S
408 *	*Phacelia imbricata patula*, g	PHIMP-G
409	*Phalaris minor*, g	PHMI-G
410 *	*Phoradendron densum*, s	PHDE-S
411	*Phoradendron californicum*, s	PHCA-S
412	*Phoradendron californicum*, t	PHCA-T
413	*Phoradendron juniperinum*, s	PHJU-S
414	*Phoradendron macrophyllum*, t	PHMA-T
415	*Phoradendron villosum*, s	PHVI-S
416	*Phoradendron villosum*, t	PHVI-T
417	*Physalis crassifolia*, g	PHCR-G
418 *	*Physalis hederaefolia*, g	PHHE-G
420 *	*Pilostyles thurberi*, g RARE LIST 4 parasitic herb	PITH-G
421	*Pinus coulteri*, s	PICO-S
422	*Pinus coulteri*, t	PICO-T
423 *	*Pinus monophylla*, s	PIMO-S
424	*Plantago* sp. Unk (native annual), g	PLA-1

425	*Plantago erecta* (native annual), g	PLER-G
426	*Plantago major* (exotic annual), g	PLMA-G
427	*Platanus racemosa*, t	PLRA-T
428	*Pleuraphis rigida*, g	PLRI-G
429	*Pleuraphis rigida*, s	PLRI-S
430	*Pleurocoronis pluriseta*, g	PLPL-G
431	*Pleurocoronis pluriseta*, s	PLPL-S
432	*Pluchea sericea*, s	PLSE-S
433	*Fake code*, g	FAKE-G
434	*Pluchea sericea*, t	PLSE-T
435	*Poa pratensis* (exotic annual), g	POPR-G
436	*Poa pratensis* (exotic annual), s	POPR-S
437	*Poa secunda*, g	POSE-G
438	*Polypogon monspeliensis* (exotic annual), g	POMO-G
439 **	*Polypogon monspeliensis* (exotic annual), s	POMO-S
440 **	*Porophyllum gracile*, g	POGR-G
441	*Porophyllum gracile*, s	POGR-S
442	*Potenilla glandulosa*, g	POGL-G
443	*Prosopis glandulosa*, s	PRGL-S
444	*Prosopis glandulosa torreyana*, g	PRGLT-G
445	*Prosopis glandulosa torreyana*, s	PRGLT-S
446	*Prosopis glandulosa torreyana*, t	PRGLT-T
447	*Prosopis pubescens*, s	PRPU-S
448	*Prunus fremontii*, g	PRFR-G
449	*Prunus fremontii*, s	PRFR-S
450	*Prunus fremontii*, t	PRFR-T

451	*Prunus ilicifolia*, g	PRIL-G
452	*Prunus ilicifolia*, s	PRIL-S
453	*Psorothamnus emoryi*, g	PSEM-G
454	*Psorothamnus emoryi*, s	PSEM-S
455	*Psorothamnus schottii*, g	PSSC-G
456	*Psorothamnus schottii*, s	PSSC-S
457	*Psorothamnus spinosus*, g	PSSP-G
458	*Psorothamnus spinosus*, s	PSSP-S
459	*Psorothamnus spinosus*, t	PSSP-T
460	*Quercus* sp. Unk, g	QUE-1
461	*Quercus agrifolia*, g	QUAG-G
462	*Quercus agrifolia*, s	QUAG-S
463	*Quercus agrifolia*, t	QUAG-T
464	*Quercus berberidifolia*, g	QUBE-G
465	*Quercus berberidifolia*, s	QUBE-S
466	*Quercus berberidifolia*, t	QUBE-T
467	*Quercus chrysolepis*, s	QUCH-S
468	*Quercus chrysolepis*, t	QUCH-T
469	*Quercus cornelius-muelleri*, g	QUCO-G
470	*Quercus cornelius-muelleri*, s	QUCO-S
471 *	*Quercus cornelius-muelleri*, t	QUCO-T
472	*Quercus kelloggii*, t	QUKE-T
473	*Quercus palmeri*, g	QUPA-G
474 *	*Quercus palmeri*, s	QUPA-S
475	*Quercus wislizenii*, s	QUWI-S
476	*Quercus wislizenii*, t	QUWI-T

477	*Quercus agrifolia* X *wislizenii*, t	QUAxW-T
478 **	*Quercus berberidifolia* X *cornelius-muelleri*, t	QUBxCO-T
479	*Rhamnus ilicifolia*, s	RHIL-S
480	*Rhus ovata*, g	RHOV-G
481	*Rhus ovata*, s	RHOV-S
482	*Rhus ovata*, t	RHOV-T
483	*Rhus trilobata*, g	RHTR-G
484	*Rhus trilobata*, s	RHTR-S
486	*Ribes indecorum*, s	RIIN-S
487	*Ribes quercetorus*, s	RIQU-S
488	*Rorippa nasturtium-aquaticum*, g (*Nasturtium officianale*)	RONA-G
489	*Rosa californica*, g	ROCA-G
490	*Rosa californica*, s	ROCA-S
491	*Rumex salicifolius*, g	RUSA-G
492	*Salix exigua*, s	SAEX-S
493	*Salix exigua*, t	SAEX-T
494	*Salix gooddingii*, t	SAGO-T
495	*Salix laevigata*, t	SALA-1T
496	*Salix lasiolepis*, s (*Salix lasiolepis bracelinae*)	SALA-2S
497	*Salix lasiolepis*, t (*Salix lasiolepis bracelinae*)	SALA-2T
498*	*Salix lucida*, t	SALU-T
499	*Salvia apiana*, g	SAAP-G
500	*Salvia apiana*, s	SAAP-S
501	*Salvia columbariae*, g -- annual - Chia	SACO-G
502	*Sambucus mexicana*, s	SAME-S
503 *	*Sambucus mexicana*, t	SAME-T

504	*Sarcostemma* sp. Unk, s	SAR-1
505	*Sarcostemma cyanchoides*(ssp *hartwegii*), s	SACY-S
506	*Sarcostemma cyanchoides* (ssp *hartwegii*), t	SACY-T
507	*Schismus barbatus*, g	SCBA-G
508	*Scirpus americanus*, s	SCAM-S
509	*Scrophularia californica floribunda*, g	SCCAF-G
510	*Scrophularia californica floribunda*, s	SCCAF-S
511	*Selaginella bigelovii*, g	SEBI-G
512	*Selaginella eremophila*, g RARE LIST 2	SEER-G
513	*Senecio* sp. Unk, s	SEN-1
514	*Senico flaccidus*, s	SEFL-S
515	*Senna armata*, g	SEAR-G
516	*Senna armata*, s	SEAR-S
517	*Setania* sp. Unk, g	SET-1
518	*Simmondsia chinensis*, g	SICH-G
519	*Simmondsia chinensis*, s	SICH-S
520	*Solidago californica*, g	SOCA-G
521	*Solanum xanti*, g	SOXA-G
522	*Solanum xanti*, s	SOXA-S
523	*Sonchus asper* (exotic annual), g	SOAS-G
524	*Sphaeralcea ambigua*, g	SPAM-G
525	*Sphaeralcea ambigua*, s	SPAM-S
526	*Sphaeralcea ambigua ambigua*, g	SPAMA-G
527 *	*Sphaeralcea ambigua ambigua*, s	SPAMA-S
528 *	*Sphaeralcea ambigua rugosa*, s	SPAMR-1S
529	*Stachys ajugoides rigida*, g	STAJR-G

530	*Stephanomeria exigua*, g	STEX-G
531	*Stephanomeria exigua*, s	STEX-S
532	*Stephanomeria pauciiflora*, g	STPA-G
533	*Stephanomeria pauciiflora*, s	STPA-S
534	*Stephanomeria virgata virgata*, s	STVIV-S
535	*Stillingia linerifolia*, g	STLI-G
536	*Stillingia linerifolia*, s	STLI-S
537	*Suaeda moquinii, g*	SUMO-G
538	*Suaeda moquinii*, s	SUMO-S
539	*Tamarix chinensis* (exotic), s	TACH-S
540	*Tamarix chinensis* (exotic), t	TACH-T
541	*Tamarix ramosissima* (exotic), s	TARA-S
542 *	*Tauchia arguta*, g	TAAR-G
543	*Tauchia parishi*i, g	TAPA-G
544	*Thamnosma montana*, g	THMO-G
545	*Thamnosma montana*, s	THMO-S
546	*Tiquilia canescens*, g	TICA-G
547	*Tiquilia palmeri*, g	TIPA-G
548	*Tiquilia palmeri*, s	TIPA-S
549	*Tiquilia plicata*, g	TIPL-G
550	*Tiquilia plicata*, s	TIPL-S
551	*Tricostema lanatum*, g	TRLA-G
552	*Tricostema lanatum*, s	TRLA-S
553	*Trixis californica*, g	TRCA-G
554	*Trixis californica*, s	TRCA-S
555	*Typha domingensis*, s	TYDO-S

556	*Urtica dioica*, g	URDI-G
557	*Urtica dioica*, s	URDI-S
558	*Vicia americana*, g	VIAM-G
559	*Vicia americana*, s	VIAM-S
560	*Viguiera parishii*, g	VIPA-G
561	*Viguiera parishii*, s	VIPA-S
562	*Viola purpruea*, g	VIPU-G
563	*Vulpia myuros* (exotic), g	VUMY-G
564	*Washingtonia filifera*, g - considered for listing but rejected	WAFI-G
565	*Washingtonia filifera*, s - considered for listing but rejected	WAFI-S
566	*Washingtonia filifera*, t - considered for listing but rejected	WAFI-T
567	*Xanthium strumarium*, g	XAST-G
568	*Yucca schidegera*, g	YUSC-G
569	*Yucca schidegera*, s	YUSC-S
570	*Yucca schidegera*, t	YUSC-T
571	*Yucca whipplei*, g	YUWH-G
572	*Yucca whipplei*, s	YUWH-S
573	*Yucca whipplei*, t	YUWH-T
574	*Ziziphus parryi*, g	ZIPA-G
575	*Ziziphus parryi*, s	ZIPA-S
576	*Ziziphus parryi*, t	ZIPA-T
	NEW ENTRIES	
577	*Peucephyllum schottii*, g	PESC-G
578	*Elymus glaucus virescens*, s	ELGLV-S
579	*Boraginaceae* sp (native annual), g	BOR-1
580	*Juncus actus*, s	JUAC-S

581	*Hordeum murionum lepornium*, g	HOMUL-G
582	*Helianthus gracilentus*, g	HEGR-G
583	*Phacelia* sp (annual)	PHA-1
584	*Eriodyction* sp (hairy)	ERI-2
585	*Echinocereus engelmannii*, s	ECEN-S
586	*Juniperus californica*, g	JUCA-1G
587	*Gutierrezia californica*, g conisdered -- rejected -- to common	GUCA-G
588	*Elymus glaucus*, s	ELGL-S
589	*Quercus wislizenii*, g	QUWI-G
590	*Chrysothamnus* sp, g	CHR-1
591	*Bromus arenarius* (exotic annual), s	BRAR-S
592	*Ericameria parishii*, g	ERPA-G
593	*Ericameria parishii*, s	ERPA-S
594	*Krameria* sp, s	KRA-1
595	*Cirsium occidentale californicum*, s	CIOCC-S
596	*Quercus berberidifolia* X *chrysolepis*, s	QUBxCH-S
597	*Populus fremontii*, g	POFR-G
598	*Populus fremontii*, t	POFR-T
599	*Eleocharis montevidensis parishii*, g	ELMOP-G
600	*Epilobium canum*, g	EPCA-2G
601	*Lessingia filaginifolia*, s	LEFI-S
602	*Rhamnus ilicifolia*, g	RHIL-G
603	*Heteromeles arbutifolia*, s	HEAR-S
604	*Ambrosia confertiflora*, g	AMCO-G
605	*Castilleja angustifolia*, g	CAAN-G
606	*Quercus kelloggii*, g	QUKE-G

607	*Pinus coulteri*, g	PICO-G
608	*Aristida adscendsious*, g	ARAD-G
609	*Eriogonum* (annual), g	ERI-3
610	*Pinus monophylla*, t	PIMO-T
611	*Arctostaphylos glauca*, g	ARGL-2G
612	*Boerhavia diffusa*, s	BODI-S
613	*Cuscuta california apiculata*, s	CUCAA-S
614	*Baccharis salicifolia*, g	BASA-1G
615	*Gnaphalium californica*, s	GNCA-1S
616	*Tauschia arguta*, s	TAAR-S
618	*Phacelia fanacetifolia*, g (annual)	PHFA-G
619	*Lupinus* sp. Unk (annual), g	LUP-1
620	*Eriastrum* sp. Unk. (annual), g	ARI-3G
621	*Erigeron foliosus foliosus*, g	ERFOF-G
622	*Oenothera californica*, g	OECA-G
624	*Aristida* sp. Unk, g	ARI-4G
625	*Aristida* sp. Unk, s	ARI-5S
627	*Ditaxis lanceolata*, s	DILA-S
628	*Physalis hederaefolia palmeri*, g	PHHEP-G
629	*Bromus madritensis rubens*, s	BRMAR-S
630	*Arabis glabra*, s	ARGL-3S
631	*Cercidium floridum floridum*, s	CEFLF-S
632	*Cercidium floridum floridum*, t	CEFLF-T
633	*Astragalus douglasii*, s	ASDO-S
634	*Juncus mexicanus*, s	JUME-S
635	*Baccharis sergeloides*, g	BASE-G

636	*Cirsium vulgare*, g	CIVU-G
637	*Cirsium vulgare*, s	CIVU-S
638	*Anemopsis californica*, g	ANCA-G
639	*Argemone munita munita*, s (Jepson has no such ssp)	ARMUM-S
640	*Nolina bigelovii*, s	NOBI-S
641	*Notholaena californica*, g considered -- rejected -- to common	NOCA-G
642	*Phoradendron californicum*, g	PHCA-G
643	*Sarcostemma* sp. Unk, g	SAR-2
644	*Justicia californica*, g	JUCA-2G
645	*Ephedra* sp. Unk, s	EPH-1
646	*Asclepias subulata*, g	ASSU-G
647	*Sphaeralcea ambigua rosacea*, s	SPAMR-2S
648	*Horsfordia newberryi*, s	HONE-S
649	*Psathyrotes ramosissima*, g	PSRA-G
650	*Alnus rhombifolia*, t	ALRH-T
651	*Pennisetum setaceum*, g	PESE-G
652	*Veronica americana*, g	VEAM-G
653	*Platanus racemosa*, s	PLRA-S
654	*Phacelia ramosissima* var *ramosissima*, g	PHRAR-G
655	*Cynodon dactylon**, s	CYDA-S
656	*Trifolium variegatum* var *variegatum*,	TRVAV-G
657	*Mirabilis multiflora*, s	MIMU-S
658	*Menodora scoparia*, s	MESC-S
659	*Distichlis spicata*, s	DISP-S
660	*Xylorhiza orcuttii*, s RARE LIST 1B	XYOR-S
661	*Tiquilia canescens*, s	TICA-S

662	*Lythrum californicum*, s considered -- rejected -- to common	LYCA-S
663	*Oenothera elata* ssp *hirsutissima* (Oenothera hokerii), s	OEELH-S
664	*Epilobium canum*, s	EPCA-2S
665	*Mimulus cardinalis*, g	MICA-1G
666	*Phacelia ramosissima*, g	PHRA-G
667	*Acalypha californica*, g considered -- rejected -- to common	ACCA-G
668	*Brickelia arguta odontolepis*	BRARO-G
669	*Clematis lingusticifolia*, g	CLLI-G
670	*Chrysothamnus paniculatus*, g	CHPA-3G
671	*Mamillaria tetrancistra*, g	MATE-G
672	*Salsola tragus**, g	SATR-G
673	*Ceanothus greggii perplexans*, s	CEGRP-S
674	*Leymus triticoides*, s	LETR-S
675	*Vitus girdiana*, t	VIGI-T
676	*Vitis girdiana*, s	VIGI-S
677	*Xylorhiza tortifolia* var *tortifolia*, s	XYTOT-S
678	*Abies grandis*, g	ABGR-G
679	*Euphorbia eriantha*, s	EUER-S
680	*Cheilanthes feei*, g	CHFE-G
681	*Achnatherum* sp, g	ACH-1G
682	*Artemesia ludoviciana albula*, g	ARLUA-G
683	*Dalea mollis*, g	DAMO-G
684	Marrubium vulgare*, g	MAVU-G
685	*Cheilanthes viscida*, g considered -- rejected -- to common	CHVI-G
686	*Fagonia laevis*, s	FALA-S
687	*Xylorhiza orcuttii*, g RARE LIST 1B	XYOR-G

688	*Melica stricta*, g	MEST-G
689	*Chrysothamnus nauseosus*, s	CHNA-S
690	*Epiloboum canum latifolium*, s	EPCAL-S
691	*Cercidium floridum floridium*, g	CEFLF-G
692	*Sporobilis airoides*, s	SPAI-S
693	*Hibiscus denudatus*, g	HIDE-G
694	*Hibiscus denudatus*, s	HIDE-S
695	*Keckiella antirrhinoides*, g	KEAN-G
696	*Isomeris arborea*, g	ISAR-G
697	*Arctostaphylos glauca*, t	ARGL-2T
698	*Prunus ilicifolia*, t	PRIL-T
699	*Brickellia fructescens*, s considered -- rejected -- to common	BRFR-S
700	*Ayenia compacta*, g RARE LIST 2	AYCO-G
701	*Carlowrightia arizonnica*, g RARE LIST 2	CAAR-G
702	*Dichelostemma capitatum*, g	DICA-G
703	*Scrophularia californica*, s	SCCA-S
704	*Hordeum murinum glaucum*, g	HOMUG-G
705	*Quercus chrysolepis*, g	QUCH-G
706	*Brassica nigra*, g	BRNI-G
707	*Brassica nigra*, s	BRNI-S
708	*Pinus jeffreyi*, s	PIJE-S
709	*Garrea* sp. Unk, s	GAR-1
710	*Menodora scoparia*, g	MESC-G
711	*Prunus andersonii*, s	PRAN-S
712	*Lycium cooperi*, g	LYCO-G
713	*Heliantheum scoparium*, g	HESC-G

714	*Gallium nutallii*, s	GANU-S
715	*Elytrigia intermedia*, s	ELIN-S
716	*Elytrigia intermedia*, g	ELIN-G
717	*Agropyron intermedium*, g	AGIN-G
718	*Rhamnus tomentella*, s	RHTO-S
719	*Datura meteloides*, g	DAME-G
720	*Cercis occidentalis*, t	CEOC-T
721	*Descurainia pinnata halectorum*, g	DEPIH-G
722	*Muilla maritima*, g	MUMA-G
723	*Agropyron intermedium*, s	AGIN-S
724	*Malacothamnus densiflorus*, s	MADE-S
725	*Hypochaeris glabra**, g	HYGL-G
726	*Cirsium scariosum*, g	CISC-G
727	*Arabis holboellii*, g	ARHO-G

Appendix 4: Metadata - Anza-Borrego Desert State Park Vegetation Map March 1998

Coverage Name: ANZAVEG

Coverage Description: The Anza Borrego Desert State Park (ABDSP) Vegetation Map depicts vegetation within the Park and its surrounding environment. The map was prepared by the Department of Fish and Game (DFG) under contract to the Department of Parks and Recreation (DPR) to assist DPR with preparation of a General Plan for ABDSP. The vegetation map was prepared using aerial photographs, field investigation, vegetation classification, and GIS processing and provides information on the location and extent of 94 vegetation types in the project area. The primary vegetation classification used for the project is based on *A Manual of California Vegetation* (Sawyer and Keeler-Wolf 1995). The data and classification work arising from this project will be used to refine future editions of the Manual. The vegetation map references other vegetation classifications as well.

Coverage Type: ARC/INFO Vector Polygon Coverage

Statistics:

Feature Class	Subclass	Number of Features	Attribute data (bytes)	Spatial Index?	Topology?
Arcs		54,084			
Polygons		20,061	114		Yes
Nodes		36,726			

Tolerances: Fuzzy = 0.740 V Dangle = 0.010 V
Coverage Boundary: Xmin = 534014.125 Xmax = 598909.438
Ymin = 3611336.750 Ymax = 3709051.500
Coordinate System Description:
Source Projection: Universal Transverse Mercator (UTM) Zone 11
Source Units: Meters Spheroid: Clarke 1866
Source Scale: 1:24,000
Resolution: 80 Meters

Source: Department of Parks and Recreation
Southern Service Center
San Diego, California

Source Data: Several data sets were used to construct the vegetation map. The map was developed based on aerial photographs, field investigation, vegetation classification, and GIS processing.

Aerial Photographs

The vegetation map is derived from three sets of color aerial photographs which together provide complete coverage of the project area. These photographs are described below:

Number of Prints	Scale of prints	Size of Prints	Month/Year	Vendor
67	1:24,000	18” x 18”	Oct./Nov. 1992	Aerial Fotobank, Inc. San Diego, California
3	1:48,000	18” x 18”	June 1993	Aerial Fotobank, Inc. San Diego, California
25	1:48,000	9” x 9”	Jun./Jul. 1996	Aerial Fotobank, Inc. San Diego, California

Metadata Figure 1 on page 159 provides more information about the coverage of aerial photographs.

Several data sets were also used to construct the vegetation map. These are described below:

Data Provided by Department of Parks and Recreation (DPR)

SPOT Imagery, Thematic Mapper Imagery, and a Merged SPOT/Thematic Mapper Image Product: A 1995 merged SPOT imagery product was generated from georeferenced and terrain-corrected multispectral and panchromatic satellite imagery by California State University San Diego (CSUSD) for DPR. This imagery was used to identify registration points for each of the 95 digital maps to minimize photographic distortion, and as a visual backdrop to assist on screen digitizing and quality control.

Topography, Hydrography, Geomorphology: These data sets were used to assist with choosing field sampling sites in different environmental settings within the project area.

Park Boundary: This boundary was used to assist in determination of the project boundary and to produce hard copy maps.

Roads and Trails: The digital map of roads and trails developed by DPR General Plan staff was used for determining access routes to sampling sites.

Palm Data: This data was developed by DPR General Plan staff and depicts the locations of palms in parts of the park. This data was used to quality control occurrences of palm dominated vegetation in the vegetation map.

Elephant Tree Data: This data was developed by DPR General Plan staff and depicts the locations of elephant trees in parts of the park. This data was used to quality control occurrences of elephant tree special communities in the vegetation map.

Data Developed for the Project by DFG

Project Boundary: This boundary was manually defined as a buffer around the park boundary on aerial photographs, using a map of the park (Earthwalk Press 1994) and a digital coverage of the park boundary as a guide. This boundary was used to determine the acreage of all vegetation types within the project mapping area.

Effective Mapping Area: DFG defined boundaries within which to delineate vegetation polygons on each aerial photograph. This information was used to assist the mosaicking process, and to assist record keeping and quality control.

Field Data Collection Points: These were collected by field staff using Global Positioning Systems (GPS) to record locations of vegetation sampling sites. This information represents the locations of most of the field samples taken during the course of the project. It was used to assist quality control of the vegetation map and to provide more detailed information about visited vegetation polygons.

Field Collected Data: This data was collected by field staff to assist in classification of vegetation within the project area, and to assist with labeling of vegetation polygons. This information was used to attribute the coverage of field data collection points and to assist quality control of the vegetation coverage.

Vegetation Database Files: DFG and DPR staff prepared 95 database files containing attributes of the vegetation coverage. These files were used to assign vegetation codes and other information to the digital map.

Vegetation Crosswalk: The primary vegetation classification for this project is based on *A Manual of California Vegetation* (Sawyer and Keeler-Wolf 1995). The vegetation crosswalk links this classification to other vegetation classifications such as the Holland vegetation classification (Holland 1986), the Wildlife Habitat Relationships (WHR) habitat classification (Mayer and Laudenslayer 1988), the Spolsky vegetation classification (Spolsky 1979), and the National Vegetation Classification (USGS 1997b).

Release Date: March 1998

Data Dictionary

The following is a description of the items contained in the Polygon Attribute Table of the ANZAVEG coverage (a detailed listing of vegetation codes for each classification follows the data dictionary):

PHOTONUM: Identification code of the aerial photograph used to define the boundaries of a polygon (e.g., 12R).

NUMID: Four digit identification number of each polygon as assigned within the effective mapping area for the photograph on which the polygon was defined.

POLYNUM: Unique identification number assigned to each polygon in the coverage (a concatenation of the fields PHOTONUM and NUMID).

SERIESFIN: The vegetation series code of each polygon.

ASSOC: The vegetation association code of each polygon. Association codes were only assigned for vegetation types for which sufficient data was available, and classification analysis was conducted.

HOLLAND: The vegetation type code of each polygon assigned using *A Preliminary Descriptions of the Natural Communities of California* (Holland 1986) updated by the County of San Diego in 1996.

WHR: The habitat type code of the polygon assigned using a Wildlife Habitat Relationships (WHR) *A Guide to Wildlife Habitats of California* (Mayer and Laudenslayer 1988).

SPOLSKY: The vegetation type code of the polygon assigned using *An Overview of the Plant Communities of Anza-Borrego Desert State Park* (Spolsky 1979).

NBSTYPE: The vegetation formation assigned to the polygon using the Federal National Biological Survey Formation classification (USGS 1997b).

MAPSYM: The four letter abbreviation of the vegetation series name assigned to the polygon. This field can be useful for labeling vegetation polygons on hard copy maps.

SHADESET: The numeric code for the color used to shade the vegetation polygon according to vegetation series on the hard copy maps provided to DPR using the DFG ARC/INFO shadeset, CMYSHADE.

SERNAME: The complete name of the vegetation series for each polygon.

ID: The method used to determine the vegetation series and association; sample (S), reconnaissance (R), or photo interpretation (P).

TOTCOV: The total cover of vegetation within the polygon; low (<15%), medium (15% to 50%), high (>50%)

WHO: The initials of the individual who assigned the attributes of that polygon; Kari Lewis (KL), Todd Keeler-Wolf (TKW), Cynthia Roye (CLR)

Relationships between Series and Associations and other Vegetation Classifications used in the Map of Anza-Borrego Desert State Park

The following table, *Relationships between series, and associations, and other vegetation classifications used in the map of Anza Borrego Desert State Park* (Metadata Table 1) , provides a complete listing of codes and vegetation types used in vegetation classifications which were used to assign attributes to the vegetation map. The codes in this table will vary from the Polygon Attribute Table of the coverage in that decimals present in the tables are absent from the attribute tables. Otherwise, the characters used in the codes are identical between the table and the Polygon Attribute Table.

Methods Used to Construct the Vegetation Map

The Anza-Borrego Desert State Park Vegetation Map was constructed through interpretation of aerial photographs, field investigation, vegetation classification, and GIS processing. Aerial photographs were interpreted and photographic signatures (characteristic appearances of vegetation and physical features) were used to delineate vegetation polygons. Vegetation throughout the project area was sampled and characterized during field visits. The resulting information was analyzed using hierarchical classification techniques (TWINSPAN) (Hill 1979) to develop a vegetation classification which lists and describes the vegetation types within the park. Polygons were assigned vegetation attributes based on interpretation of the aerial photographs, field data, vegetation classification, and ground reconnaissance. Vegetation polygons were transferred to the GIS through a process which involved scanning vegetation polygons into digital image files, converting them to vector GIS coverages, editing them using ARC/INFO software, georeferencing them using the aerial photographs and SPOT Imagery, mosaicking mapping areas together using the MAPJOIN command in ARC/INFO, and attributing them using database files developed in DBASE IV and Paradox software programs.

Assessment of Data Quality

The features of this map are accurate to within 80 meters.

Intended Use of the Anza-Borrego Desert State Park Vegetation Map

This map was designed for use in developing a General Plan for Anza-Borrego Desert State Park. The map is not intended for regulatory use, and should not be used in place of ground level survey work required pursuant to environmental laws or regulations.

Use of the Digital Anza-Borrego Desert State Park Vegetation Map for Display and Analysis

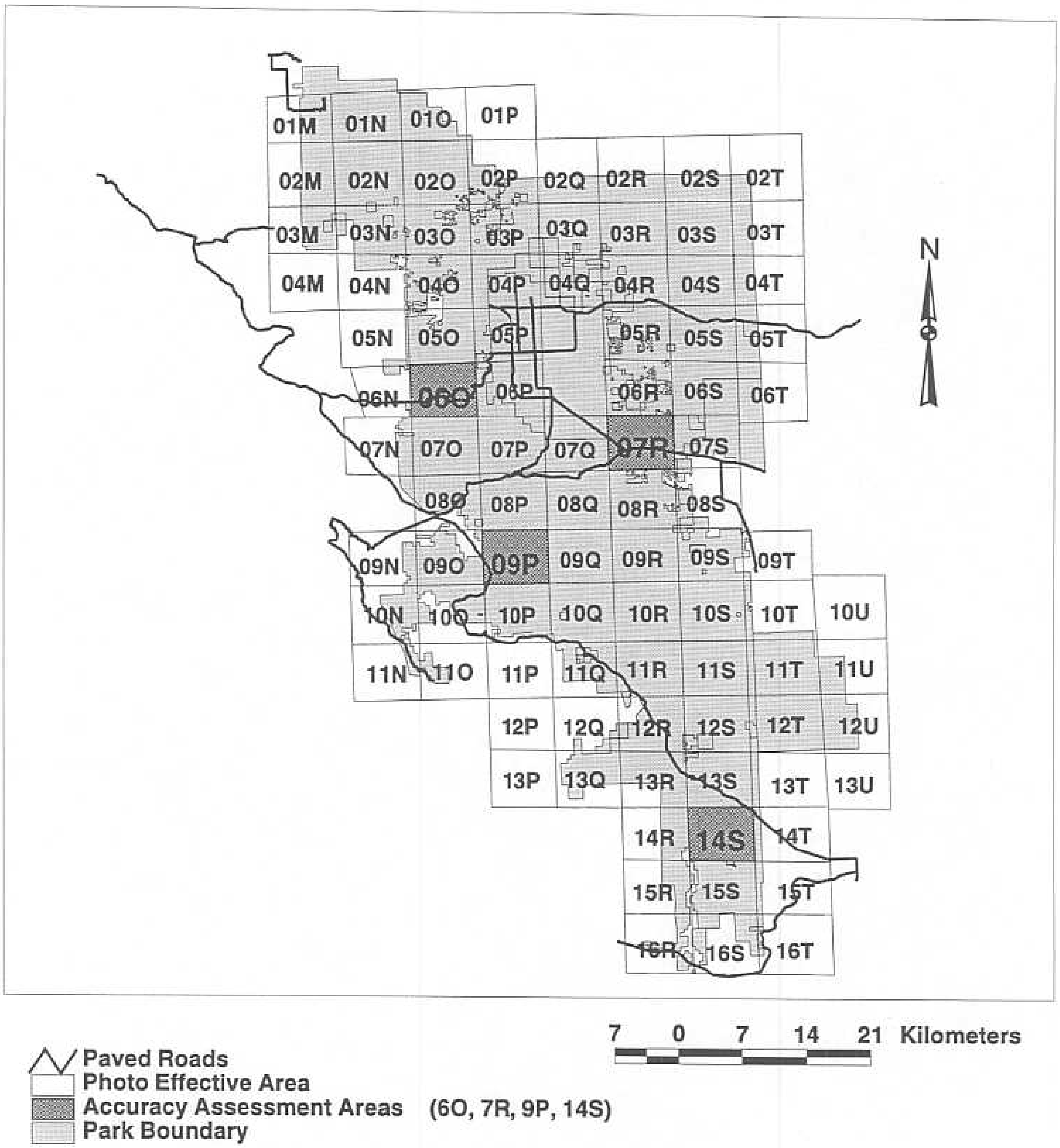
Because the GIS coverage of the ABDSP Vegetation Map was created using ARC/INFO software, it can be displayed or analyzed in ARC/INFO or ARCVIEW software. To use the coverage in ARC/INFO it is necessary to import the export file ANZAVEG.e00.

To use the coverage in ArcView software, obtain the shape file ANZAVEG.shp and the ArcView legend files ANZAVEG1.avl through ANZAVEG4.avl, and copy them to a directory on your computer. Using ArcView, open a project and open a view. To select a theme, use the theme selection dialog window, select the appropriate path to the ANZAVEG.shp file (e.g. C:\base\anzaveg.shp) and press OK. The coverage will appear as a theme in your view. You may make the theme visible by depressing the small ANZAVEG theme button. The vegetation coverage will appear in your view. To use the legend file provided to shade the map with the color scheme used to shade the original hard copy maps, double click on the theme bar for the ANZAVEG shape file to obtain the legend editor. In the legend editor, load a legend file such as ANZAVEG1.avl, press OK to approve the field SERIESFIN, and press the “Apply” button. The shade set will appear in your view legend for display.

Below are a list of usgs quads, and a list of individual coverages included on the CDROM

Metadata Figure 1

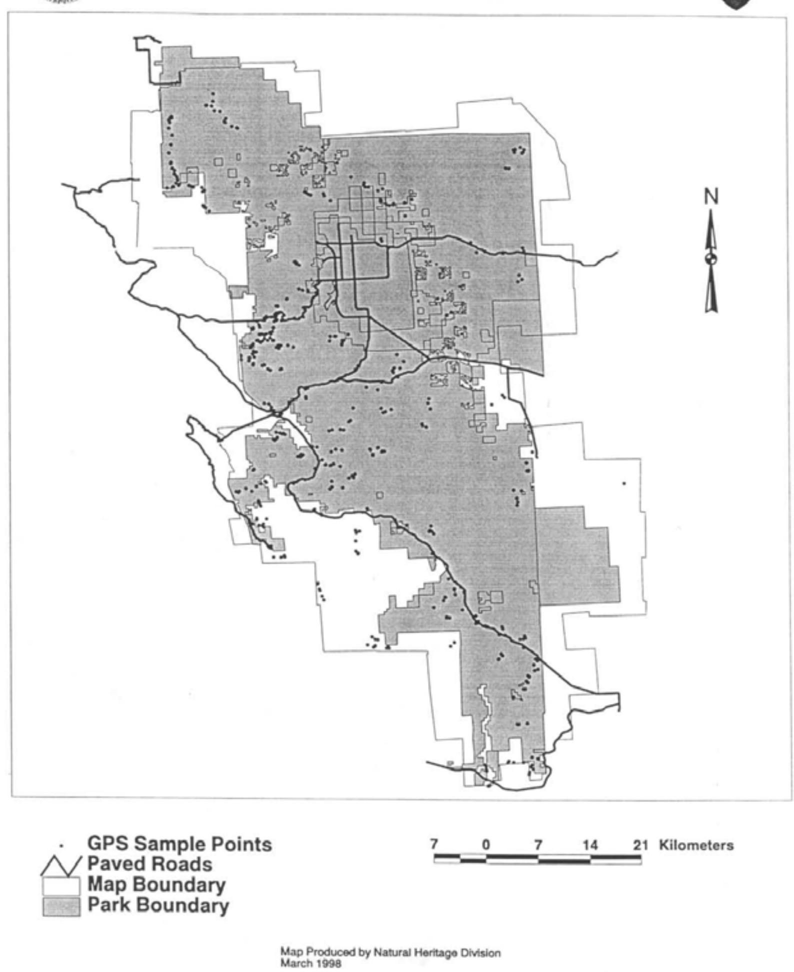
Effective Mapping Areas
Anza-Borrego Desert State Park



Map Produced by Natural Heritage Division
March 1998

To use the coverage in ArcView software, obtain the shape file ANZAGPS.shp and copy it to a directory on your computer. Using ArcView, open a project and open a view. To select a theme use the theme selection dialog window, select the appropriate path to the ANZAGPS.shp file (e.g. C:\base\anzagps.shp) and press ENTER. The coverage will appear as a theme in your view. You may make the theme visible by depressing the ANZAGPS theme button. The coverage of field data collection points will appear in your view.

Figure 1
Distribution of GPS'ed Sample Points in Anza-Borrego Desert State Park



Appendix 5: Metadata - Anza-Borrego Desert State Park Map of Field Data Collection Points Recorded using Global Positioning System (GPS) March 1998

Coverage Name: ANZAGPS

Coverage Description: The Anza-Borrego Desert State Park (ABDSP) Map of Field Data Collection Points depicts locations where vegetation sampling was conducted to support development of the ABDSP vegetation map. These points were recorded using a Global Positioning System (GPS) consisting of a base station and several portable receivers. The coverage contains attributes characterizing site quality and threats to natural vegetation in the areas visited.

Coverage Type: ARC/INFO Point Coverage

Statistics:

Feature Class	Subclass	Number of Features	Attribute data (bytes)	Spatial Index?	Topology?
Points		417	150		

Tolerances:	Fuzzy = 9.337 N	Dangle = 0.000 N
Coverage Boundary:	Xmin = 536090.000	Xmax = 584959.750
	Ymin = 3611577.500	Ymax =3704951.750

Coordinate System Description:

Source Projection: Unversal Transverse Mercator (UTM) Zone 11

Source Units: Meters
Spheroid: Clarke 1866
Source Scale: 1:24,000
Resolution: 5 Meters

Source: Department of Parks and Recreation
Southern Service Center
San Diego, California

Source Data: Two primary data sets contributed to the development of the digital map of field data collection points. Digital GPS data files collected during the course of field vegetation sampling are the basis for the point locations. These data were collected in 1996 and 1997 with Trimble Navigation Pathfinder Basic and Geoexplorer II portable GPS receivers. Sampling forms completed by field staff were used to attribute the point coverage with information about site quality and threats observed to natural vegetation in these areas. Also included are vegetation series and association labels for each site. Metadata Figure 1 on page 163 provides more information about the distribution of field data collection points within the vegetation mapping area.

Release Date: March 1998

Data Dictionary

The following is a description of the items contained in the Point Attribute Table of the ANZAGPS coverage:

GPS_DATE: The date on which the GPS point was collected in the field in YYYYMMDD format.

DATAFILE: The original identification code assigned by the GPS receiver to the digital point file collected in the field. This code is in lowercase with a .cor extension (e.g. n020620a.cor).

GPSFILENUM: The identification code assigned to the original GPS digital point file in uppercase without a .cor extension (e.g. N020620A).

SERIESFIN: The code for the vegetation series found at the sample site.

ASSOCIATIO: The code for the vegetation association found at the sample site. Association codes were only assigned for vegetation types for which sufficient data was available and classification analysis was conducted.

POLYNUM: The number of the vegetation polygon in which the sample was taken (e.g. 14S1185).

THREAT1 - THREAT8: The two digit Natural Diversity Data Base (NDDB) threat code which represents threats detected at the sample site. Metadata Table 1 on page 164 provides a listing of threat codes and the threats they represent. Up to eight threats may be listed per site.

THREATINT1 - THREATINT8: The code which represents the intensity of the threat detected at the site: 1 = Light, 2 = Medium, 3 = Heavy. The threat intensity fields correspond with the threat fields of the same number (e.g. THREATINT1 corresponds with THREAT1). Up to eight threat intensities may be listed for each site.

SITEQUAL: The code which characterizes the quality of the site: A = excellent, B = good, C = fair, D = poor.

SAMPLENUM: The unique three digit number of the sample conducted at the site as given on the hard copy field data form.

RELEVENUM: The identification number of the releve (sample) conducted within a vegetation polygon.

Methods Used to Construct the Field Data Collection GPS Point Map

The map of field data collection points was constructed from GPS data gathered during vegetation sampling visits to the field. Sampling locations were recorded using a GPS consisting of a base station and several portable receivers. The portable units were used to collect several readings at each vegetation sampling point. These readings were differentially corrected using data from the base station and GPS software, and averaged to provide a single location for each site where field vegetation sampling occurred. Using GPS software, the points were projected in to the UTM Zone 11 projection to yield a GIS coverage of most of the vegetation sampling sites visited. Some of the sampling areas visited are not included in the digital map due to periodic unavailability of satellite transmissions which prevented the collection of GPS data.

Data on threats and site quality were entered from field data forms completed in 1996 and 1997 into a Paradox 6 database using DBASE 4 format (.dbf). The database file was used with the JOIN command in ARC/INFO to assign attributes to the point coverage of sampling points.

Assessment of Data Quality

The features of this map are accurate to within 5 meters.

Intended Use of the Field Data Collection GPS Point Map

This map was designed for use in developing a vegetation map for Anza-Borrego Desert State Park and environs, and to provide information about threats and site quality for areas visited during field collection of vegetation data. It is intended for use by DPR staff in development of a General Plan for the Park. The coverage may be used in conjunction with hard copies of the field survey forms provided to DPR to georeference more detailed site level information available in the forms. The field data collection point map is not intended for regulatory use, and should not be used in place of ground level survey work required pursuant to environmental laws or regulations.

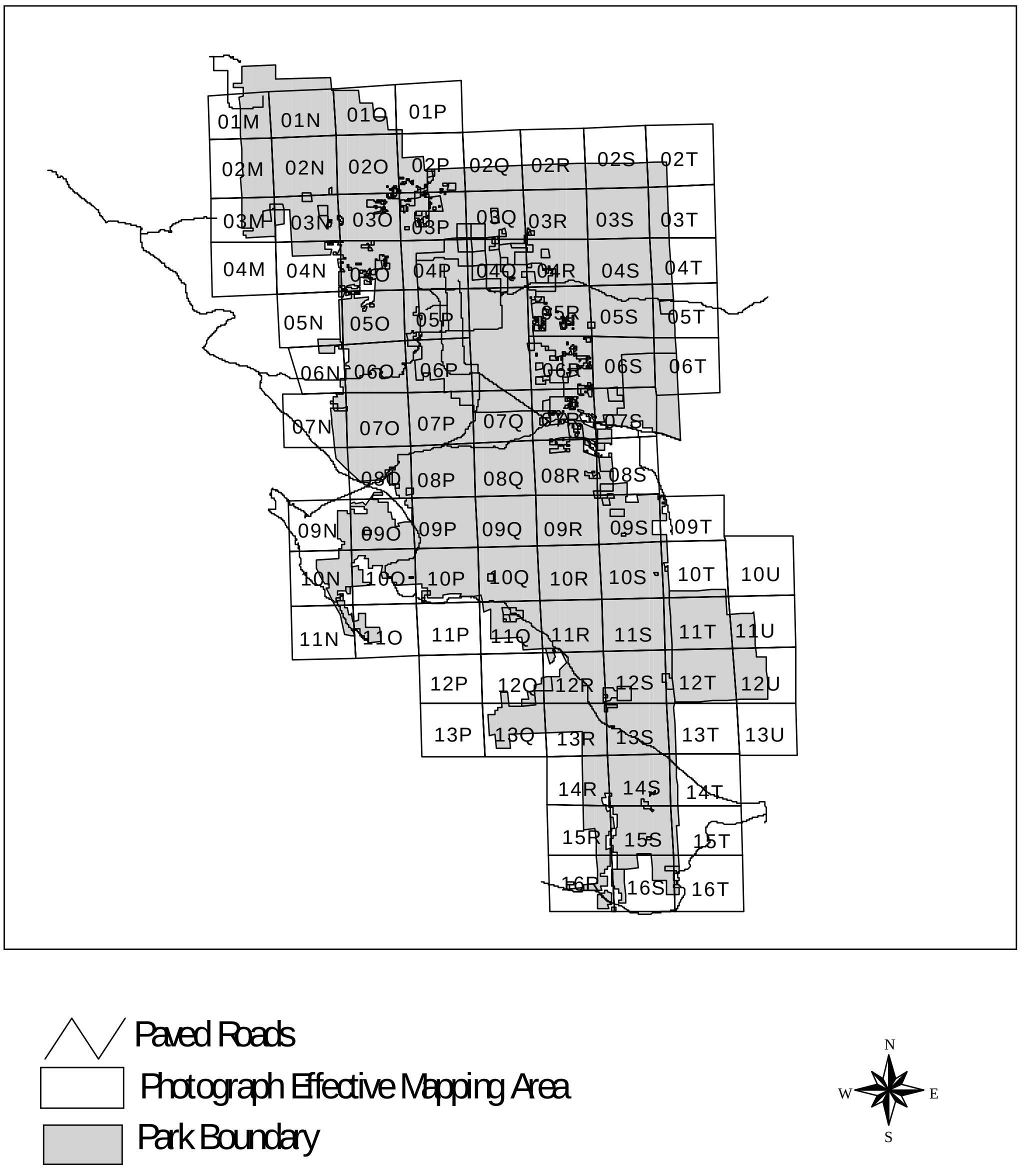
Use of the Digital Map of Field Data Collection GPS Points

Because the GIS coverage of GPS Field Data Collection Points was created using ARC/INFO software, it can be displayed or analyzed in ARC/INFO or ARCVIEW software. To use the coverage in ARC/INFO, it is necessary to import the export file ANZAGPS.e00.

To use the coverage in ArcView software, obtain the shape file ANZAGPS.shp and copy it to a directory on your computer. Using ArcView, open a project and open a view. To select a theme use the theme selection dialog window, select the appropriate path to the ANZAGPS.shp file (e.g. C:\base\anzagps.shp) and press ENTER. The coverage will appear as a theme in your view. You may make the theme visible by depressing the ANZAGPS theme button. The coverage of field data collection points will appear in your view.

Metadata Figure 1

Photograph Effective Mapping Areas
Anza-Borrego Desert State Park and Environs
Vegetation Mapping Project



Metadata Table 1
Natural Diversity Data Base (NDDB) Threat Codes

Threat Code	Threat Description
01	Development
02	Off-Road Vehicle (ORV) Activity
03	Agriculture
04	Grazing
05	Competition from Exotics
06	Logging
07	Insufficient Population/Stand Size
08	Altered Flood/Tidal Regime
09	Mining
10	Hybridization
11	Ground Water Pumping
12	Dam/Inundation
13	Other
14	Surface Water Diversion
15	Road/Trail Construction/Maintenance
16	Biocides
17	Pollution
18	Unknown
19	Vandalism/Dumping
20	Foot Traffic/Trampling
21	Improper Burning Regime
22	Over-collecting/poaching
23	Erosion or Runoff
24	Altered Thermal Regime
25	Landfill
26	Degraded Water Quality
27	Wood Cutting
28	Military Operations
29	Recreational Use (non-ORV)
30	Nest Parasitism
31	Non-Native Predators
32	Rip-rap, Bank Protection
33	Channelization
34	Feral Pigs

Appendix 6
Anza Borrego Desert State Park Vegetation Mapping Project
Schematic Diagram of Digital Deliverables
March 1998